Vol. XXI. Part 8.

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The Journal of the Department of Agriculture of Victoria, Australia.

August, 1923.

PRINCIPAL CONTENTS

The Water Requirements of Farm Crops

Passion Fruit Culture

A Neglected Market for Our Wines

Poultry Feeding Experiment

Tobacco Growing in United States

Weeds and their Eradication

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OF

THE DEPARTMENT OF AGRICULTURE,

VICTORIA, AUSTRALIA.

CONTENTS.—AUGUST, 1923.

		PAGE
The Water Requirements of Farm Crops (*continued*)	*A. E. V. Richardson, M.A., M.Sc.*	449
Passion Fruit Culture in Victoria	*J. Farrell*	482
Prohibition of Removal of Bees		488
Brown Rot of Stone Fruit		489
Poultry Feeding Experiments	*W. C. Rugg*	494
Poultry Notes from the Research Farm	*W. Pederick*	498
A Neglected Market for our Wines	*F. de Castella*	499
Tobacco Growing in United States		508
Weeds and Their Eradication	*H. W. Davey, F.E.S.*	510

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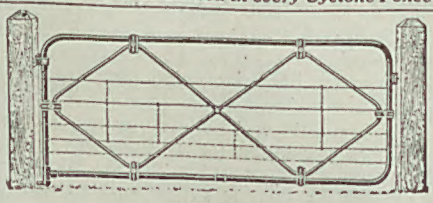

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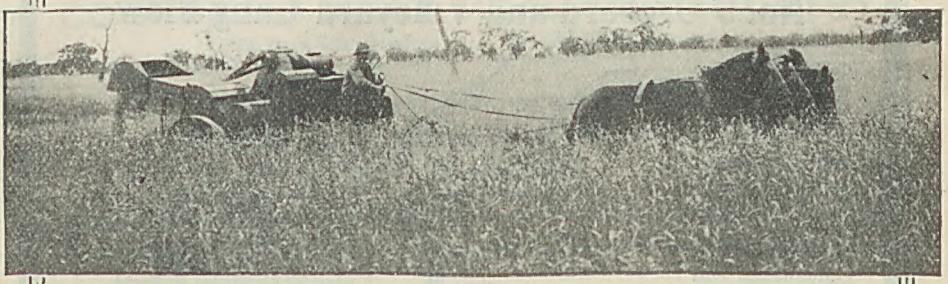

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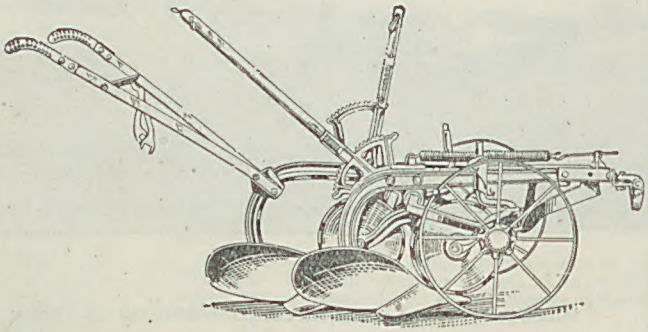

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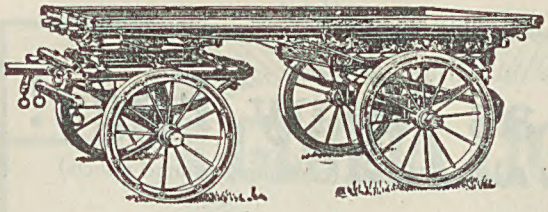

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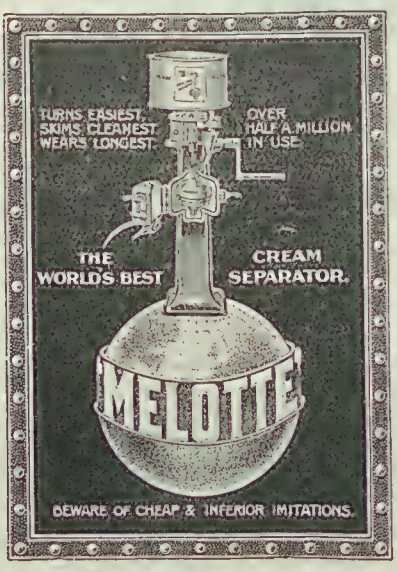

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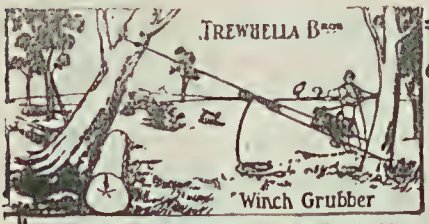

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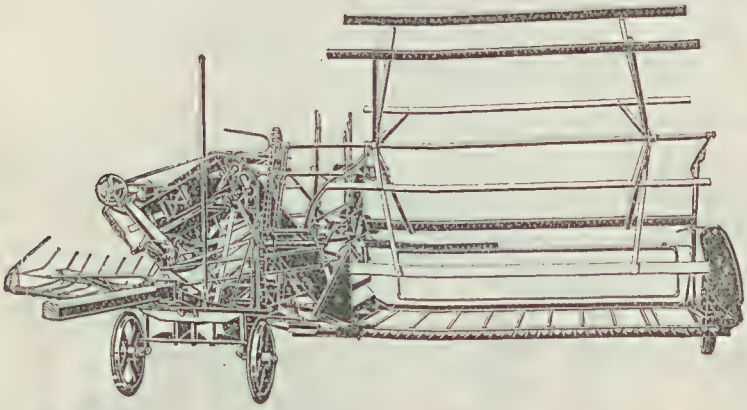

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Department of Agriculture

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Vol. XXI. **August, 1923.** **Part 8.**

WATER REQUIREMENTS OF FARM CROPS.

(Continued from page 404.)

By A. E. V. Richardson, M.A., B.Sc., Agricultural Superintendent.

THE RAISING OF DROUGHT-RESISTANT VARIETIES OF WHEAT.

The production of new varieties of wheat to meet the requirements of a low transpiration rate opens up a field of vast possibilities. Just what causes drought resistance in field plants is not definitely known. Certain crops—particularly the sorghums—have a low Transpiration Ratio compared with other summer-grown crops, and are known to be very resistant to drought. In this case the ability to withstand drought is due to the fact that during hot, dry weather, the leaves roll up and decrease the area of transpiring surface. Other drought-resistant plants have thickened cuticles, relatively few stomata, or are covered with a waxy coating, or a covering of hairs, which tend to lessen evaporation.

Fitting (1911) has suggested that drought-resistant crops approach the condition of desert plants, which possess a high osmotic pressure, and are therefore able to extract moisture from relatively dry soils in which the water films are very thin.

It was formerly thought that transpiration was controlled by the stomata and that transpiration varied with stomatal aperture.

Darwin (1898, 1904) based his horn hygroscope and differential temperature methods of estimating stomatal aperture on this assumption.

Lloyd (1908) investigated the relation between stomatal aperture and transpiration, and showed that the graph of transpiration did not follow changes in stomatal aperture, and concluded that except when the stomata were almost closed stomatal aperture did not control transpiration.

Knight (1917) carried out experiments to determine the relationship between stomatal opening and transpiration and showed that there was no agreement between the two, because a decreasing transpiration rate is often accompanied by stomatal opening, and *vice versâ*. He showed that a high water content of the leaf influenced the rate of transpiration, and that though the stomata are very sensitive to light, they may continue to open even though the water content of the leaf is decreasing.

Livingston (1906, 1913) showed that the rate of transpiration rose during the early morning hours, but the rise was checked before the evaporating power of the atmosphere, as measured by the rate of loss from atmometers reached a maximum, i.e., some factor other than external atmospheric changes tends to reduce the rate of transpiration.

Shreve (1914) demonstrated the existence of this inhibiting factor in various plants.

Livingston concluded that the regulating mechanism was not stomatal in nature, because of its early appearance before any stomatal aperture was to be expected.

Trelease and Livingston (1916) showed that maximum stomatal aperture was reached three hours later than the maximum transpiring rate.

Livingston and Brown (1912) demonstrated that the water content of transpiring leaves was not constant throughout the day, but that it tended to decrease during the morning and reached a minimum at about the same time as the evaporating power of the atmosphere reached a maximum. The explanation offered was that as the evaporating power of the air increases, a corresponding increase in the transpiration results, which reduces the water content of the leaf, which in turn lowers the transpiration rate by the incipient drying of the walls of the cells. Hence the view that the rate of transpiration is controlled by changes in stomatal aperture appears to be untenable.

Transpiration is essentially the evaporation of moisture from a wet leaf surface and fluctuations in atmospheric conditions—temperature, relative humidity, wind velocity—which increase or decrease evaporation from a free water surface produce precisely similar effects on plants. Varieties of wheat which, by their habit of growth, mature when the atmospheric conditions are favorable for intense evaporation, transpire water more freely and have a higher Transpiration Ratio than varieties the ripening period of which is coincident with less intense environmental conditions.

We have seen that while wheat varieties do not differ widely in respect to the transpiration ratio for dry matter, they do show very material differences in the transpiration ratio for grain, mainly because of specific differences in the migration ratio.

This quality of high migration ratio was shown to be associated with a well-developed root system, with short straw and relatively scanty foliage.

Earliness of maturity may be of great importance for the production of varieties suited to arid localities.

October is the critical period for the wheat crop in Australia. The month of October is invariably associated with high temperatures, low

humidity, and hot northerly winds. Varieties of wheat which are well on towards maturity before these hot northerly winds set in are likely to have a low water requirement, and to suffer less from shortages of soil moisture than the late maturing varieties, the ripening period of which is coincident with intense evaporation.

The varieties grown in the more arid portions of the wheat belt are mainly early-maturing types, *e.g.*, King's Early, Gluyas, Steinwedel, Mac's White, Bunyip, and Canberra. High migration ratio and earliness of maturity are, therefore, two important qualities for wheats grown in arid districts.

Seelhorst (1910) after fourteen years' work, extending from 1896 to 1910, concluded that soil moisture content can influence ripening characters to such an extent that varietal characters are lost.

Harris (1914) showed that wheat matured fourteen days earlier with a moderate content of soil moisture than with soil containing a high percentage of water. He also showed that the effect of fertilizers was dependent on the amount of soil moisture present. Other workers who have conducted experiments on the relation of transpiration to soil moisture content are Il'Enkov (1865), Sorauer (1880), Maercker (1896), Burgerstein (1901, 1904), Deherain (1902), Fortier (1902), Seelhorst and Bunger (1907), Ohlmer (1908), Preul (1908), Pfeiffer (1912), and Thom (1913).

With irrigated crops the moisture content of the soil may be controlled for the benefit of the crop. The soil moisture content may be kept within the limits which enable rapid growth to be made at relatively low water cost. With moderate degrees of soil humidity the maximum production is obtained at the lowest water cost. With the wheat-grower the position is very different. Practically the entire wheat crop of Australia is dry-farmed.

A considerable amount of moisture may be conserved by fallowing, and especially by summer fallowing, and losses by evaporation from the soil may, to some extent, be controlled by harrowing or inter-tilling the growing crop.

On the whole, however, the wheat-grower is at the mercy of the elements; and the moisture content of the soil, especially in spring and early summer months, is in most years below the optimum for vigorous growth..

The production of varieties of wheat suited to the peculiar environmental conditions of the wheat belt is more important to our future wheat production than the possible control of the soil conditions to suit the needs of the varieties now grown in the wheat areas.

Varieties which mature early are likely to have a lower water requirement than late maturing types, because their ripening period is coincident with less severe environmental conditions.

Varieties with a high migration ratio have a much lower water requirement for grain, and can therefore use the scanty moisture supplies for grain production more economically than those with low migration ratios.

Hence early-maturing types with a high migration ratio are likely to be the best yielding and most prolific varieties for the semi-arid conditions characteristic of a large portion of the wheat belt of Australia.

There are two broad lines on which we may work for the production of a variety suited to arid districts—(1) Acclimatisation, (2) Hybridisation. The introduction of wheats produced under foreign climates is likely to prove of value in two ways—(*a*) as a direct source of new and useful varieties, (*b*) as an indirect means by cross-breeding of improving prolific local types with the specific excellence of the introduced type.

The introduction of varieties grown for centuries in the driest parts of the world offers a means of securing types which may be of extreme value for Australian conditions. Some of these varieties would doubtless be of direct use. They would be cultivated as soon as their yielding capacity had been demonstrated.

The most promising method for the production of early prolific varieties is hybridisation. Great impetus has been given to genetic

Fig. 33.—Cross-bred wheat "Gallipoli," with pollen parent on left and ovule parent on right.

research during the past twenty years by the re-discovery of Mendel's Law, and many interesting applications of the law have been worked out for the inheritance of unit characters of wheat.

Mendel's conception of the plant being made up of a number of unit characters, each of which is independently inherited, in accordance with a definite scheme, is of the utmost value to the plant breeder, and has enabled wheat breeding to be established on a sound basis. The desirable unit characters of two or more wheat varieties can now be combined by hybridisation into one plant, with the certainty that there will be, in the segregating generation of the cross-bred, at least one homozygous, or pure breeding form, containing the desirable characters.

At the State Research Farm, Werribee, exhaustive investigations have been made to determine the mode of inheritance of certain unit

characters in wheat and barley. Some of these investigations have involved the classification and segregation of over 20,000 plants.

The following pairs of characters have been found respectively dominant and recessive with wheat:—

Dominant.	Recessive.
1. Red or Bronze coloured chaff	White chaff
2. Bald ears	Bearded ears
3. Lax ear	Dense ear
4. Woolly chaff	Glabrous chaff
5. Hollow straw	Solid straw
6. Dark endosperm (in Spelt types and Cedar)	Starchy endosperm
7. Early maturity	Late maturity

The most important quality a wheat can possess is prolificness. What factors constitute prolificness are not definitely known.

So far as genetic characters are concerned prolificness appears to be dependent on the length of ear, number of spikelets in the ear, number of grains per spikelet, and the average weight of the grain. It is also possibly dependent on tillering capacity.

Investigations were made at Werribee to determine whether high-yielding power and low-yielding power, as a whole, are heritable characters. The method adopted was to make crosses between the most prolific wheats, *e.g.*, Federation, Yandilla King; and low-yielding wheats, *e.g.*, Huguenot and Bobs. On field plots Huguenot for many years stood out as the lowest-yielding wheat grown at Werribee. Its cultivation, owing to these low yields, has since been discontinued. In the second generation the individual plants were grown in centgener squares, and the prolificness of each plant was measured by the yielding capacity of a hundred of its progeny.

While the pure lines of Federation, Yandilla King, Bobs, and Huguenot each showed normal frequency curves when the weights of individual plants were plotted, the second generation cross-breds showed distinct segregation into low-yielding and high-yielding variants.

Plants taken from the high-yielding group were sown in centgener squares alongside plots from the low-yielding group. The following were the results:—

Weight of Grain in Centgener Plots from High-yielding and Low-yielding Variants Selected from F_2 Cross-bred Wheats.

Variety.	Huguenot x Federation.	Huguenot x Yandilla King.	Bobs x Federation.	Average of three crosses.
	grams.	grams.	grams.	grams.
1. High-yielding variants ..	160	138	240	179
2. Low-yielding variants ..	106	127	197	143

In each case the plants taken from the high-yielding variants gave considerably greater yields in the F_3 generation than the plants taken from low-yielding variants, showing that the differences in yielding

capacity were transmitted to the progeny. The centgener method of testing tends to eliminate fluctuations in yield due to external environment. A description of the method used in planting these centgener plots was described by Richardson and Green.*

Before leaving the subject of prolificness, one further point should be borne in mind. If we cross two plants which differ in prolificacy, the plants of the second generation often produce segregated families of plants, with a range of variation at least equal to that of the parents, and occasionally extreme forms occur, which exceed the limits of prolificacy of either parent.

These forms may be isolated and made the starting point of new types. We may take as an illustration a new cross-bred barley produced at the State Research Farm, Werribee, by crossing a prolific six-rowed barley (Skinless) with a two-rowed bearded malting type (Pryor). From this cross a six-rowed bearded barley was obtained which gave a race of plants with a higher yield and higher migration ratio than either of the parent forms.

TABLE XXXVII.

AVERAGE WEIGHT OF GRAIN AND MIGRATION RATIO IN CROSS-BRED BARLEY PRODUCED BY CROSSING SIX-ROWED BEARDLESS (SKINLESS) AND TWO-ROWED BALD (PRYOR).

Variety.	Average weight of 100 plants.	Average weight of grain from 100 plants.	Percentage of grain to total crop.
	grams.	grams.	%
Two-rowed Bearded (Pryor) ..	1,572	368	23
Six-rowed Bald (Skinless)	1,824	640	35
Crossbred b 6 (Skinless x Pryor) ..	1,952	824	42

The results obtained in these tests† were confirmed by field tests, which showed that the average yield of the fixed cross-bred was 28 per cent. higher than the six-rowed parent.

While the yielding capacity of wheat and barley varieties is the resultant of genetic characters as well as environmental conditions, there is evidence to show that prolificness is a heritable character, and that F_2 cross-breds between prolific and non-prolific varieties segregate into low and high yielding variants, and that among these latter homozygous types are often obtained which exceed in yield the average prolificness of either parent.

Much more work requires to be done to determine the factors which make up the complex of prolificness, but the experience of wheat-breeders in Australia shows definitely that cross-breeding wheats of selected parentage is the most potent means of producing new types of value for the wheat belt.

In the production of Federation wheat, the result of composite crossing of Purple Straw (a prolific local variety) with Yandilla (a Fife-Indian variety), William Farrer succeeded in obtaining the most

* *Journal of Agriculture of Victoria*, March, 1916, pp. 140–146.

† A. E. V. Richardson—Production of Cereals for Arid Districts—Bulletin No. 7, Institute of Science and Industry, Melbourne.

prolific and popular variety used in the wheat belt. Mr. H. Pye, Cerealist at Dookie College, has produced several cross-bred varieties, *e.g.*, Currawa and Major, which are widely grown in the more favoured portions of the wheat belt.

The writer produced a number of cross-bred wheats while in charge of cereal-breeding investigations in the Department of Agriculture, South Australia. Among these a cross-bred—Clubhead x Yandilla King—since named Gallipoli, has done remarkably well in tests made at various centres in the wheat belt. Clubhead is an early maturing brown-chaffed variety, with short straw and bold, compact, awnless ears. It is, however, quite unsuited for cultivation, as it shakes badly at harvest time. Yandilla King, on the other hand, is a late maturing,

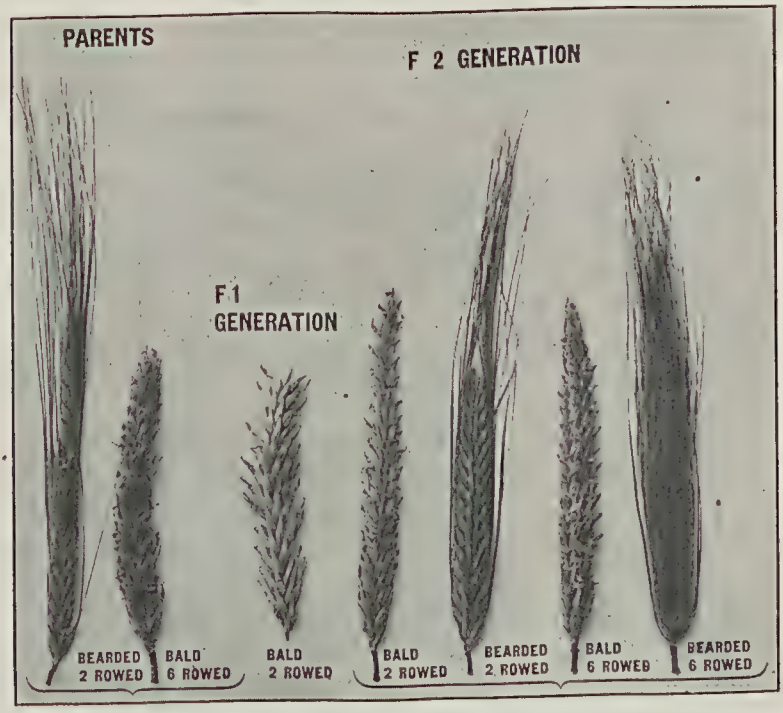


Fig. 34.—Cross-bred barleys produced by hybridising Pryor (two-rowed, bearded) and Skinless (six-rowed, bald).

F_1, First generation, hybrid. F_2, Second generation, genotypes.

white-chaffed variety, with somewhat lax and slightly tip-awned ears. It holds its grain very firmly. The cross-bred Gallipoli is a short-strawed wheat with strong upright straw, and difficult to thresh. The ears are brown in colour, with dense, compact, bald ears. Compared with Federation, it is much shorter in the straw, darker brown in colour, more compact, and matures about the same time. It is also more resistant to rust and flag smut, and has yielded better in nearly every field test in which it has been tried.

For six years (1915-1920) during which it was being tested at the State Farm, Werribee, the average yields of Gallipoli, Federation, and Yandilla King were as follows:—

Gallipoli	22 bushels	38	lbs.
Federation	19 ,,	43	,,
Yandilla King	19 ,,	20	,,

During the seasons 1920-22 it was tested at the following centres:—Longerenong, Salisbury, Warracknabeal, Cowangie, Carwarp, and Rutherglen, with Federation and other varieties. The results for three years were as follows:—

Centre.	Federation.	Gallipoli.
Longerenong Agricultural College ..	46·1	50·9
Salisbury	43·2	46·4
Warracknabeal	27·2	29·7
Cowangie	21·7	22·4
Carwarp	13·3	14·4
Rutherglen	13·9	16·3
Werribee	27·9	30·7

By cross-breeding wheats of selected parentage new varieties may be produced which combine earliness of maturity, high migration ratio, and high-yielding capacity. Practically the whole of the varieties of wheat grown to-day in the Australian wheat belt are the products of local wheat-breeders' efforts, and the majority of the prolific varieties are of cross-bred origin.

With cross-breeding it is possible to create new combinations of unit characters which never existed before. Each character is independently inherited in accordance with the Mendelian law, and it is possible to associate almost any combination of characters in one variety.

To make substantial progress we need to analyze thoroughly our material to determine the unit characters which make up the complexity of the cereal plant, and determine precisely the inheritance of each group of characters. Some of this work has been done, *e.g.*, the inheritance of what might be termed the botanical characters has been determined. But the more important and difficult part—the determination of the factors which compose the mosaic of prolificness, drought resistance, low water requirements—remains to be determined.

Once the material is analyzed and the mode of inheritance worked out, wheat breeding will be placed on a scientific basis, and future work will yield results of astonishing value to the Commonwealth. The work of cereal improvement is in its infancy in Australia, and the striking success already achieved by hybridisation is extremely encouraging. Milling quality, disease resistance, drought resistance, and high yielding capacity have been imparted to different varieties of wheat to a high degree.

The nature of the Australian climate, and the fact that the rainfall rapidly diminishes and the water requirement of wheat increases as we pass from the coast to the interior, makes a study of drought resistance and the production of varieties with low water requirement of fundamental importance. With the evolution of hardier strains with low water requirements, new territories may be subjugated, and the effective utilization of areas already under cultivation will be made more certain.

APPLICATION OF RESULTS TO IRRIGATED LUCERNE.

Under favorable soil and climatic conditions lucerne exceeds all other forage crops in weight and quality of product per acre. Approximately 100,000 acres of irrigated land in Victoria have been sown with this forage.

The relationship between the water supply and crop production, and the factors which affect the water requirements of lucerne are, therefore, of great practical importance.

The work of building storages and locks on the Murray River is well under way, and within the next decade the problems of irrigation in the Murray Valley will assume great national importance. Hitherto there has been little local data to guide the irrigationist in extracting the maximum return from each irrigable acre.

Some important problems for determination were—

1. The water requirement of lucerne and the variation water requirement at different periods of the year, and from season to season.

2. The effect of varying quantities of irrigation water on the yield of lucerne, and the determination of the optimum quantity of water for the production of lucerne at lowest water cost.

3. The effect of fertilizers on the growth of lucerne, and the water cost of dry matter produced.

Definite information regarding the first problem can be secured only by conducting transpiration tests over a period of years. Data regarding the last two problems can be best secured by a series of carefully controlled field tests.

The water requirement of lucerne was determined in triplicate for four seasons at the Rutherglen Pot-culture House. For the whole period the average Transpiration Ratio was 790.5. This is equivalent to 7.82 inches of rain for the production of 1 ton of dry matter. In other words, at Rutherglen the water requirement of lucerne was just double that recorded for wheat.

The Transpiration Ratio varies from season to season in accordance with the intensity of the physical environmental factors—air temperature, wet-bulb depression, wind velocity, evaporation. While the average Transpiration Ratio for lucerne for each season does not exhibit wide fluctuations, the water cost of the various cuttings does show considerable variation.

Thus lucerne produced in the spring or early summer shows a much lower water cost than lucerne which matures in February or March. This is clearly shown in each of the four years during which the test was conducted. The high water cost of lucerne produced in midsummer and early autumn is due to the much greater intensity of the water-dissipating factors at this season of the year. Throughout the four years the cuttings were made either when the lucerne began to bloom or when new shoots commenced from the base of the crowns. In three of the years during which the tests were made seven cuttings were obtained. During 1917-18, however, only two cuttings were made.

The results for the four seasons are summarized in Table XXXVIII.

Table XXXVIII.

Water Transpired, Weight of Dry Matter Produced, and Transpiration Ratio for Lucerne, Rutherglen Experiment Farm—Seasons 1915–1919.

Number of Cutting.	Season 1915–16.			Season 1916–17.			Season 1917–18.			Season 1918–19.			Average Transpiration Ratio for four years.
	Water Transpired.	Dry Matter.	Transpiration Ratio.	Water Transpired.	Dry Matter.	Transpiration Ratio.	Water Transpired.	Dry Matter.	Transpiration Ratio.	Water Transpired.	Dry Matter.	Transpiration Ratio.	
	lbs.	grams		lbs.	grams		lbs.	grams		lbs.	grams		
First ..	4·38	6·57	302	20·33	12·03	767	20·71	14·06	669	32·04	26·27	554	573
Second ..	27·28	16·64	744	30·62	24·57	566	24·46	23·44	474	52·10	28·72	824	652
Third ..	21·97	16·90	590	21·61	23·87	411	19·99	13·90	653	21·77	16·21	610	566
Fourth ..	25·47	10·05	1,150	20·53	17·40	535	20·57	8·65	1,079	42·38	13·35	1,441	1,051
Fifth ..	26·03	9·75	1,212	17·98	11·82	690	34·65	13·36	1,177	26·16	9·06	1,310	1,099
Sixth ..	42·17	17·65	1,085	31·93	10·29	1,409	25·91	13·17	893	23·71	10·41	1,034	1,105
Seventh ..	13·55	11·52	534	16·07	8·09	902	..	..	..	36·17	14·17	1,159	865
Total Crop	160·85	89·08	819	159·07	107·93	675	146·29	86·58	767	234·33	118·19	901	790·5

The most striking feature of the table is the variation in the water requirement of lucerne at different periods of the year. During each year the cuttings made early in the season, *i.e.*, before the hot, dry weather was ushered in, were produced at a much lower water cost than the later cuttings. The three cuttings harvested during spring and early summer gave, over a four-year period, an average water requirement of 597, compared with a water requirement of 1,085 for the three cuttings harvested during summer and early autumn. In other words, the lucerne harvested during the summer months—when the water-dissipating influences were at a maximum—was produced at almost twice the water cost of the lucerne grown during the cooler part of the year.

Moreover, in most cases the earlier cuts gave greater yields of dry matter than the later cuts. For these reasons it would appear that where lucerne is grown on limited rainfalls, and under dry-farming conditions, it would be advisable to confine the cuttings to spring and early summer, when dry matter is produced abundantly at low water cost, and to graze the plants during the hot weather when the water requirement is high.

In other words, under dry-farming conditions lucerne should be allowed to grow freely at the season when the crop shows the lowest water requirement, and checked during periods when it produces dry matter at a maximum water cost.

The irrigation farmer has not, however, the same need to economize his water supply. The irrigationist can within certain limits supplement the rainfall by applying water to his crops at a time when they most need it, and he can, therefore, secure a full yield with a given expenditure of water, and can maintain lucerne fields in full vigour more or less permanently.

Under dry-farming conditions the available moisture supply may be insufficient to maintain continuous active transpiration, with the result that crop yields are lowered, and the plant may suffer actual injury by shortage of soil moisture.

We may say, therefore, that the water requirement of lucerne varies with the season, and more particularly with the time of the year at which it is cut, but for districts with climatic conditions similar to Rutherglen, the average water requirement is 790, and for districts similar to Werribee the water requirement is approximately 685 (Table 1). It is the most expensive of the farm crops tested so far as the water cost of dry matter is concerned.

To determine the effect of variations in water and fertilizer supply on the yield of lucerne and on the water cost of dry matter, a series of field investigations was begun at the State Research Farm, Werribee, in 1919. Ten acres of irrigable land were set apart for this purpose. The area had been used as an irrigation field for stud cereals from 1912 to 1918, but during 1919 it was carefully regraded to insure the most uniform and regular distribution of water.

A series of 40 border checks was laid out 5 chains long by $\frac{1}{2}$ a chain wide, and two cement supply channels were used to convey the water from the main channel to the field. Shallow cement drainage ditches were used to collect any surplus water from the plots. At the entrance of the field each supply channel was provided with a special Dethridge meter (Fig. 36), to record the quantity of water used on each plot. Each levee bank was sown with a drill width of lucerne 6 ft. 5 in. wide.

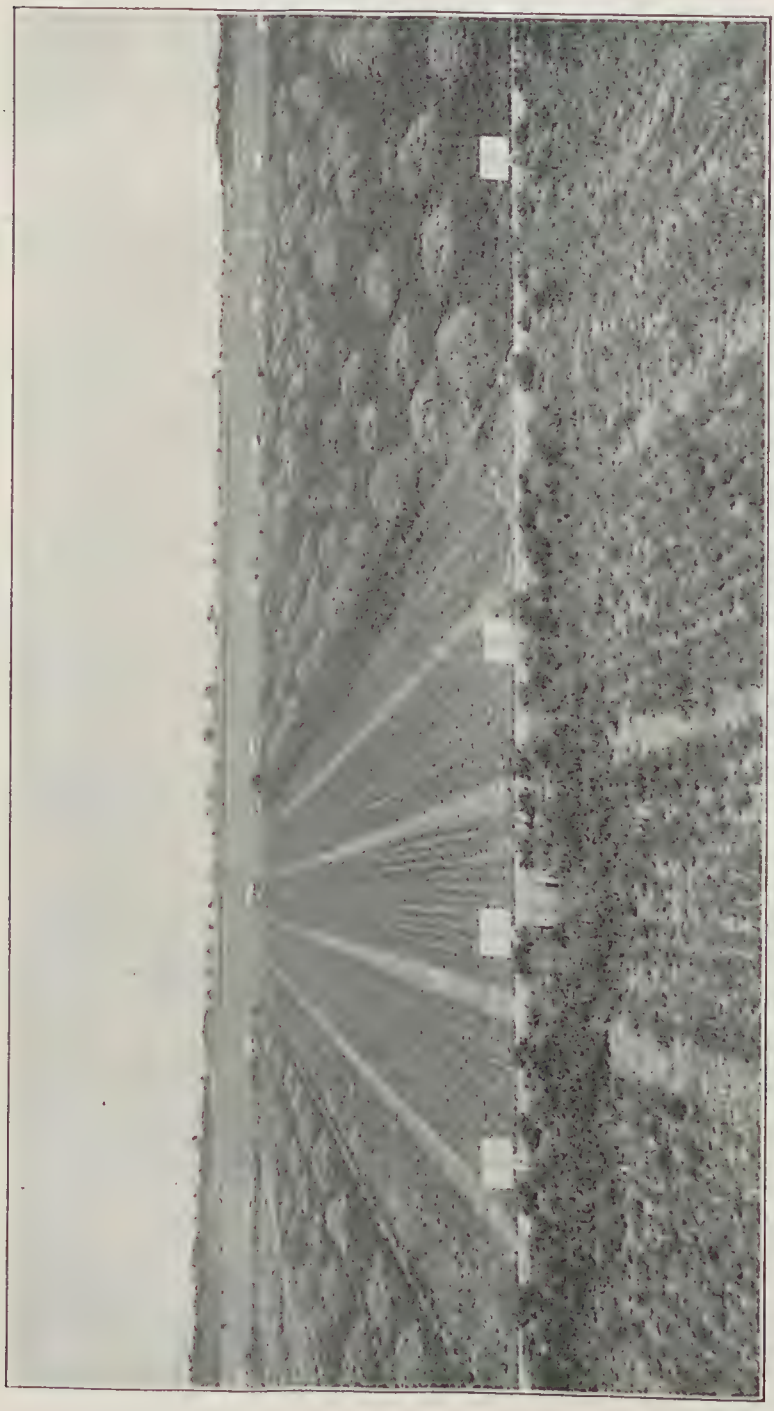


Fig. 35.—View of Rate of Watering Tests, Permanent Irrigation Field, State Research Farm, Werribee.

These strips were cut separately from the plots contained within each border, and were disregarded in determining the plot yields.

The remaining land between each levee bank was sown with three plots, each a drill width 6 ft. 5 in. wide, with a 22-in. space between each drill. The central strip was left unmanured. The other strips were sown with superphosphate (2 cwt. per acre) and rock phosphate (phosphate content equivalent to 2 cwt. super.) respectively. With the first series of plots—the rate of watering tests—quantities of water ranging from 18 to 48 inches were applied in six inch applications. One of the plots received no irrigation water.

All plots were cut separately and cured. Each cured lot at the time of weighing was sampled, and the moisture content determined. Thus the yield of dry matter for each plot was obtained, and also the yields of commercial hay calculated on an 85 per cent. dry basis.

Fig. 35 gives a general view of the rate of watering tests. The three central plots received no irrigation water throughout the three years during which the test was made. On the left are three plots receiving 24 inches of water per annum, and on the right the plots receiving 30 inches of water. In the foreground are a set of manurial trials.

The results of the rate of watering tests are summarized in Table XXXIX.

Table XXXIX.

Effect of Varying Quantities of Irrigation Water on the Yield of Lucerne Hay (containing 85 per cent. Dry Matter).

State Research Farm, Werribee (1921-23).

Irrigation Water applied.	1921–22.	1922–23.	Average for Two Seasons.
	cwt.	cwt.	cwt.
1. Nil	35·8	23·6	29·7
2. 18″ water ..	116·3	105·8	111·0
3. 24″ „ ..	137·25	131·4	134·4
4. 30″ „ ..	150·3	147·0	148·6
5. 36″ „ ..	162·4	143·8	153·1
6. 48″ „ ..	171·1	159·9	165·5

The results of these tests show clearly the influence of water on yields of lucerne. Plot 1 received no irrigation water. The yields from this plot may be regarded as the measure of the growth from the rainfall received during the growing period of the crop. For the season 1921-22 the rainfall was 19.26 inches, and for 1922-23 only 12.69 inches of rain fell.

Yields of 35.8 cwt. and 23.6 cwt. per acre were obtained on these rainfalls, an average for the two seasons of 29.7 cwt. per acre. From these non-irrigated plots only two cuttings of lucerne were obtained each season. From all irrigated plots five cuttings were obtained.

An application of 18 inches of irrigation water resulted in a large increase in yield compared with the non-irrigated plot.

The average yield for the two seasons was 111.05 cwt. per acre—an increase over the control plot of 81.35 cwt.

Additional increments of water up to the limit used in the tests—48 inches per acre—gave increases in crop yield, but the rate of increase from successive moieties gradually fell off. Even the heaviest irrigation (48 inches) gave yields which showed a substantial margin of profit over and above the cost of the irrigation water applied.

The water cost of producing dry matter in lucerne with varying quantities of water was determined. The results for two seasons are summarized in the following Tables:—

Table XL.

Effect of Variations in Water Supply on Yield and on Water Cost of Lucerne—Season 1921-22.

State Research Farm, Werribee.

Treatment of Plot.	Water available for crop (rain and irrigation water).	Yield of Dry Matter per acre.	Quantity of water used to produce 1 ton of Dry Matter.	Amount of Dry Matter produced per acre foot of water used.
	inches.	tons.	inches.	tons.
1. No Irrigation ..	19·26	1·530	12.59	.960
2. 18″ irrigation water (3 6″ waterings) ..	37·26	4·930	7.55	1.584
3. 24″ water— (4 6″ waterings) ..	43·16	5·865	7.36	1·632
4. 30″ water— (5 6″ waterings) ..	49·36	6·375	7·74	1·548
5. 36″ water— (6 6″ waterings) ..	55·26	6·885	8.02	1·488
6. 48″ water— (8 6″ waterings) ..	68·16	7·271	9·37	1·280

Table XLI.

Effect of Variations in Water Supply on Yield and Water Cost of Lucerne—Season 1922-23.

Treatment of Plot.	Water available for crop (rain and irrigation water).	Yield of Dry Matter per acre.	Quantity of water used to produce 1 ton of Dry Matter.	Amount of Dry Matter produced per acre foot of water used.
	inches.	tons.	inches.	tons.
1. No irrigation ..	12·69	1·030	12·15	·974
2. 18″ water— (3 6″ waterings) ..	30·69	4·496	6·82	1·758
3. 24″ water— (4 6″ waterings) ..	36·69	5·584	6·57	1·826
4. 30″ water— (5 6″ waterings) ..	42·69	6·247	6·83	1·756
5. 36″ water— (6 6″ waterings) ..	48·69	6·111	7·97	1·506
6. 48″ water— (8 6″ waterings) ..	60·69	6·796	8·93	1·344

Table XLII.

Effect of Variations in Water Supply on Yield and Water Cost of Lucerne—Average of Two Seasons.

State Research Farm, Werribee.

Treatment of Plot.	Water available for crop (rain and irrigation water).	Yield of Dry Matter per acre.	Quantity of water used to produce 1 ton of Dry Matter.	Amount of Dry Matter produced per acre foot of water used.
	inches.	tons.	inches.	tons.
1. No irrigation ..	15·97	1·28	12·37	·961
18″ water— (3 6″ waterings ..	33·97	4·713	7·20	1·664
3. 24″ water— (4 6″ waterings) ..	39·97	5·724	6·98	1·718
4. 30″ water— (5 6″ waterings) ..	46·02	6·311	7·29	1·645
5. 36″ water— (6 6″ waterings) ..	51·97	6·498	7·99	1·500
6. 48″ water— (7 6″ waterings) ..	64·42	7·033	9·18	1·310

On the non-irrigated plot the actual water cost of dry matter was much higher than on any of the irrigated plots. The quantity of water required for each ton of dry matter produced was 12.59 and 12.15 acre inches respectively, an average for the two years of 12.37 acre inches.

With the heaviest irrigation, namely, 48 inches of water, the amount of water required for the production of a ton of lucerne was 9.43 inches and 8.93 inches respectively, an average for the two seasons of 9.18 acre inches

On the other hand, with moderate irrigation, *i.e.*, from 18 to 30 inches, the water cost of lucerne was much the lowest, the amount varying in 1921-22 from 7.36 to 7.74 inches per ton of dry matter, and, in 1922, from 6.57 to 6.83 inches per ton of dry matter respectively.

The most efficient use of water was obtained with the 24-in. irrigation during both seasons. During 1921-22 each ton of dry matter required 7.36 acre inches, whilst during 1922-23 only 6.57 acre inches were required.

In other words, on plots which received 24 inches of irrigation water, dry matter was produced at a water cost of 6.98 inches per ton, compared with a water cost of 9.15 inches with heavy irrigation, and 12.47 inches with no irrigation.

These water costs represent, of course, actual water costs under field conditions and include losses, by

(1) Evaporation from the soil,
(2) Seepage or percolation, and
(3) Transpiration.

Just how much of the total water is lost by percolation or evaporation from the soil under field conditions is difficult to determine unless the crops are grown in specially constructed drain gauges. The losses by seepage from subsoils, such as those at Werribee, when moderate quantities of irrigation water are used, are probably exceedingly small. Nor are the losses by evaporation from the soil very great in comparison with the amount used by transpiration, especially when the growth of the

crop is normal or vigorous. Some losses certainly occur after each cutting of lucerne, when the land is bare, but within a few days of cutting the lucerne covers the ground, and for the greater part of the period of growth the whole of the soil is covered and shaded by a dense mass of vegetation.

Under these circumstances we may assume that with a good stand of lucerne, and with moderate irrigation, practically the whole of losses which occur are due to transpiration.

On the other hand, the growth on the non-irrigated plot is usually short and sparse, so that losses by evaporation from the soil are likely to be high.

With heavy irrigations some losses may occur through deep percolation, more especially where subsoils are porous. Losses from this source

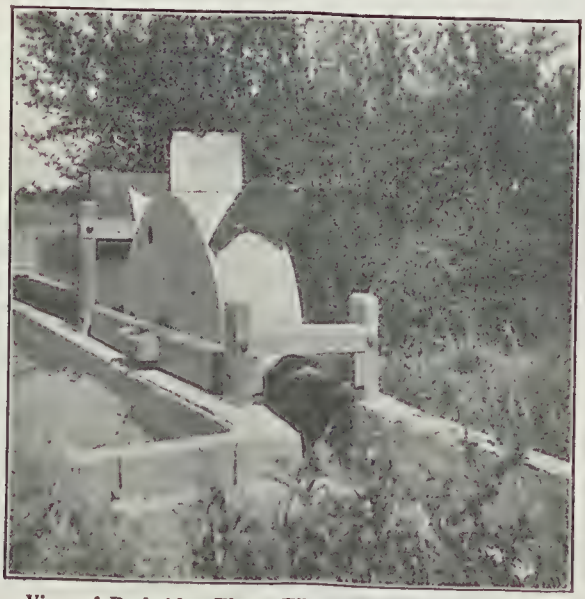


Fig. 36.—View of Dethridge Water Wheel, specially designed to measure small quantities of water.

have, however, been negligible at Werribee even with heavy watering. Losses by evaporation from the soil are likely to be rather greater with heavy irrigations on account of the higher content of the surface layer of soil and the more frequent watering.

A fertilizer test was included in the scheme of investigation work in order to determine the relative water costs of unmanured and fertilized lucerne.

With each variation in the amount of irrigation water used, plots treated with superphosphate were sown alongside unmanured contrals.

Comparisons were, therefore, obtained of the water cost of dry matter with manured and unmanured plots under varying conditions of water supply.

The results for the two seasons are summarized in Tables XLIII. and XLIV.

Table XLIII.

Effect of Superphosphate on the Yield and on the Water Cost of Lucerne Grown under Conditions of Varying Water Supply—Season 1921-22.

State Research Farm, Werribee.

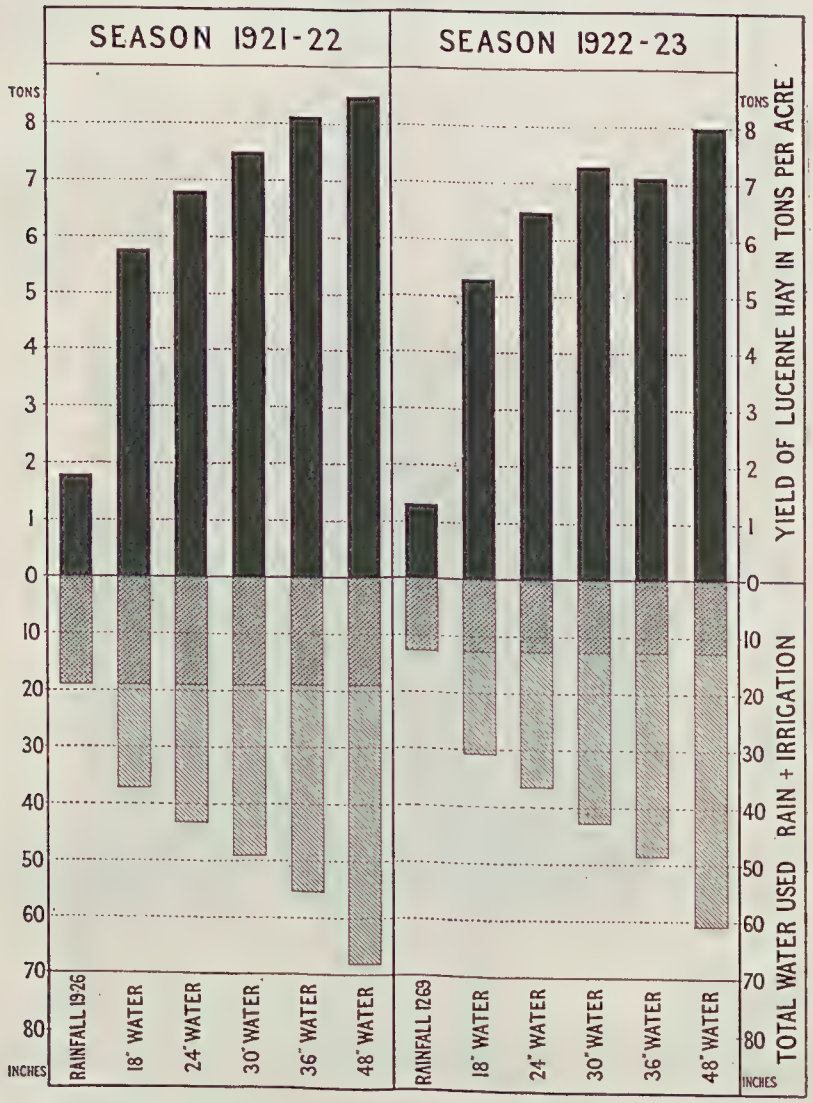
Treatment of Plot.	Water available for crop (rain and irrigation water).	Yield of Dry Matter per acre.	Amount of Dry Matter produced per acre foot of water used.	Quantity of water used to produce 1 ton of Dry Matter.
	inches.	tons.	tons.	inches.
1. No irrigation—				
A. Superphosphate ..	19·26	1·541	·237	12·50
B. No manure ..	19·26	1·402	·872	13·73
2. 18″ water—				
A. Superphosphate ..	37·26	4·875	1·569	7·64
B. No manure ..	37·26	4·598	1·479	8·10
3. 24″ water—				
A. Superphosphate ..	43·16	6·009	1·670	7·18
B. No manure ..	43·16	5·563	1·545	7·76
4. 30″ water—				
A. Superphosphate ..	49·36	6·583	1·599	7·49
B. No manure ..	..	6·060	1·472	8·14
5. 36″ water—				
A. Superphosphate ..	55·26	7·038	1·527	7·85
B. No manure ..	55·26	6·927	1·503	7·98
6. 48″ water—				
A. Superphosphate ..	68·16	7·263	1·276	9.38
B. No manure ..	68·16	7·051	1·240	9.66

Table XLIV.

Effect of Superphosphate on the Yield and on the Water Cost of Lucerne Grown under Conditions of Varying Water Supply—Season 1922-23.

State Research Farm, Werribee.

Treatment of Plot.	Water available for crop (rain and irrigation water).	Yield of Dry Matter per acre.	Amount of Dry Matter produced per acre foot of water used.	Quantity of water used to produce 1 ton of Dry Matter.
	inches.	tons.	tons.	inches.
1. No irrigation—				
Superphosphate ..	12·69	1·147	1·085	11·06
Nil	12·69	0·837	0·791	15·16
2. 18″ water—				
Superphosphate ..	30·69	4·636	1·812	6·62
Nil	30·69	4·088	1·598	7·51
3. 24″ water—				
Superphosphate ..	36·69	5·763	1·864	6·37
Nil	36·69	5·193	1·698	7·06
4. 30″ water—				
Superphosphate ..	42·69	6·358	1·787	6·71
Nil	42·69	6·264	1·760	6·81
5. 36″ water—				
Superphosphate ..	48·69	6·477	1·596	7·51
Nil	48·69	5·988	1·473	8·13
6. 48″ water—				
Superphosphate ..	60·69	7·433	1·468	8·16
Nil	60·69	6·213	1·227	9·76



GRAPH SHOWING RELATIONSHIP BETWEEN WATER SUPPLY AND YIELD OF LUCERNE

Fig. 37.—Relation of Water Supply to Lucerne Yields.

Black columns = Yield of Lucerne. Double-hatched columns = Rainfall.
Single-hatched columns = Irrigation water applied.

The results of these tests demonstrate the value of a water-soluble phosphate in stimulating crop yields and reducing the water cost of the dry matter produced. With each quantity of water used the yield of lucerne from the fertilized plots is higher than that of the unmanured controls, and conversely the water cost of dry matter is much reduced by the use of a soluble phosphate.

The effect of the superphosphate was very pronounced during the second season of the tests. The average of the water costs for the season 1922-23 was 9.07 acre inches per ton of dry matter for the unmanured plots, as against 7.74 acre inches per ton for the plots treated with a soluble phosphate. Thus the average water cost of all dry matter produced during the second year was 17.2 per cent. higher on the unmanured plots than on those treated with superphosphate.

It is apparent that the use of a moderate dressing of a water soluble phosphate materially increases the yield of lucerne and lowers the water cost of each ton produced.

The average water costs of lucerne (expressed in acre inches of water per ton of dry matter produced) for the fertilized plots and the unmanured controls are summarized in Table XLV.:—

Table XLV.

Effect of Superphosphate on the Water Cost of Lucerne Crops Grown with Varying Quantities of Water.

Treatment of Plots.	Acre inches of water required per ton of Dry Matter produced.						
	Without Irrigation.	With 18″ water.	With 24″ water.	With 30″ water.	With 36″ water.	With 48″ water.	Average for all Plots.
No Manure ..	14·44	7·80	7·41	7·47	8.06	9·71	9·15
Superphosphate ..	11·78	7·13	6·77	7·10	7·68	8·77	8·20

Compared with the unmanured plot, superphosphate produced lucerne at a much lower water cost with all quantities of water tested, the effect of the superphosphate being more marked with no irrigation and with the heaviest irrigation. The average water costs for the unmanured lucerne was 11.6 per cent. higher than the water cost of lucerne treated with superphosphate. It was shown (page 274) that a liberal dressing of superphosphate in the presence of an abundant supply of nitrates brought about a marked reduction in the water requirements of wheat, particularly for grain. Victorian soils are deficient in phosphoric acid, and applications of water-soluble phosphate have proved to be essential for the profitable production of wheat throughout the State. Nor is there any less need to supply phosphate with lucerne, for a normal crop of irrigated lucerne removes from the soil far more phosphoric acid than does the average wheat crop.

To gain definite information in the nutritive elements removed by a lucerne crop, an analysis was made of all the cuttings—stems and leaves—obtained throughout the period of growth from the C series of

tests (effect of variations in the water content of soil on the Transpiration Ratio), at the Rutherglen Pot-culture House.

The soils in this series of tests were maintained throughout the period of growth at 30 per cent., 45 per cent., 50 per cent., 75 per cent., 90 per cent. of saturation. The plants in the pots maintained at the highest degree of saturation died before the conclusion of the experiment, and the analyses of the plants from this series were excluded.

In a previous publication* the writer showed that a crop of lucerne producing 7 tons of dry matter (7 tons 17½ cwt. of hay) would remove from the following nutrients per acre in the hay—

Nitrogen	321 lbs.
Potash	348 lbs.
Phosphoric acid	65 lbs.
Lime	349 lbs.

Stored up in the roots of such a crop were the following nutrients per acre—

Nitrogen	69.2 lbs.
Potash	36.0 lbs.
Phosphoric acid	16.2 lbs.
Lime	39.6 lbs.

If we compare these quantities with the needs of a 30-bushel wheat crop we find that a lucerne crop yielding 7 tons of dry matter would remove from the soil sufficient phosphoric acid to supply the needs of five wheat crops, and would leave in the roots sufficient of the same ingredients to bring a 30-bushel wheat crop to maturity. The amount of nitrogen removed by the lucerne would supply the needs of nine wheat crops, and the amount left in the roots would suffice for two such crops.

Potash was removed in quantities sufficient for the needs of 36 wheat crops, and the roots contained enough to furnish potash for 30-bushel wheat crops.

The lucerne plant secures the greater part of its nitrogen from the atmosphere through the activity of the nitrogen fixing bacteria living symbiotically on its roots.

With respect to potash, most Victorian soils, especially clays and clay loams, are abundantly supplied with this ingredient, so that dressings of potash are usually unnecessary except when lucerne is grown on sandy or peaty soils, both of which are deficient in potash.

The position is very different with respect to phosphoric acid. The majority of Victorian soils are markedly deficient in this ingredient and the response of all crops, particularly wheat, to dressings of phosphate is very marked. One would not expect that heavy yields of lucerne could be maintained without liberal supplies of phosphate, in view of the fact that a seven-ton crop of lucerne would remove five times as much phosphoric acid as a 30-bushel wheat crop.

The results of three seasons' work on the permanent irrigation manurial tests at Werribee confirm this view.

The results of such tests are summarized in Table XLVI.

* *Journal of Agriculture*, Victoria, August, 1916.

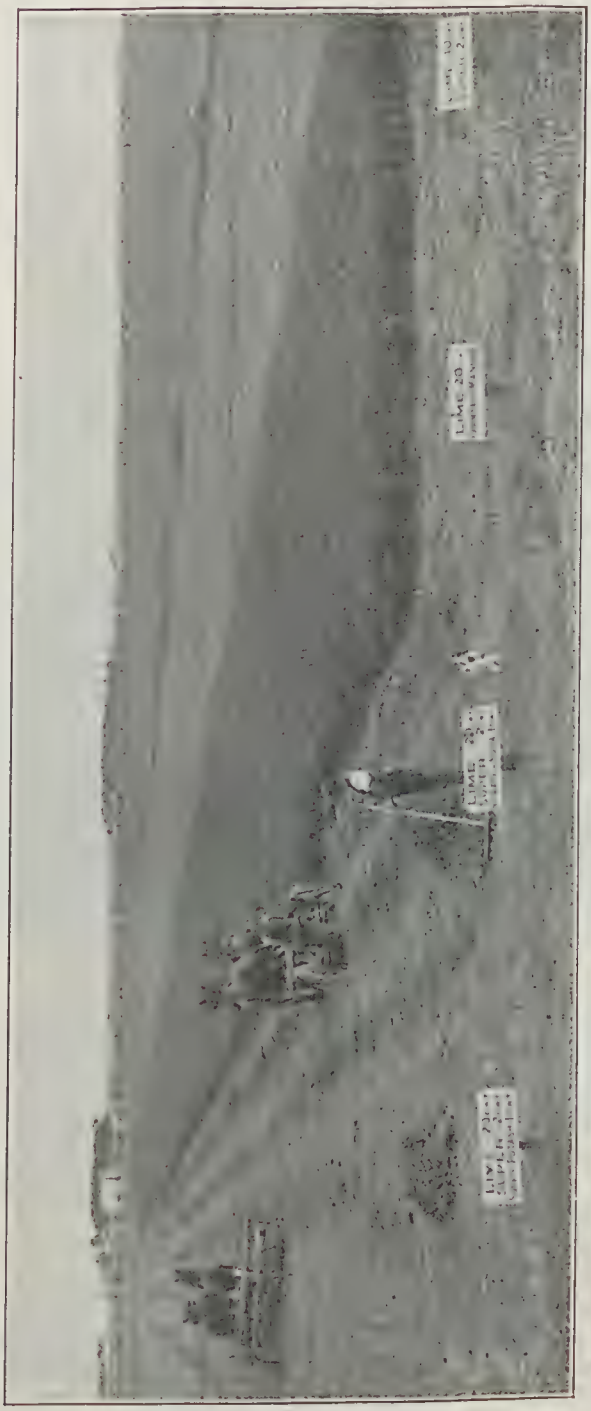


Fig. 38.—View of manurial trials with irrigated lucerne, State Research Farm, Werribee.

Table XLVI.

Effect of Varying Quantities of Superphosphate on Yield of Irrigated Lucerne—Permanent Manurial Tests—(Average of Three Seasons) 1920, 1921, 1922.

State Research Farm, Werribee

Plot Treatment.	Yield for 1922-3.	Average for Three Years.	Increase due to Fertilizer.
	cwt.	cwt.	cwt.
1. No manure	103·1	125·1	..
2. Super. 1 cwt.	122·6	135·3	10·2
3. „ 2 cwt.	137·0	143·6	18·5
4. „ 3 cwt.	143·0	146·3	21·2
5. „ 4 cwt.	148·2	151·6	26·5
6. „ 2 cwt. and Gypsum 30 cwt. ..	149·8	158·2	33·1
7. Basic Slag (equivalent to 2 cwt. super.) ..	122·7	133·8	8·7
8. Bone fertilizer (equivalent to 2 cwt super.)	122·2	130·0	4·9

The results of this test show that all phosphates tested gave a substantial increase over the unmanured control, but that superphosphate was much superior to either basic slag or bone fertilizer.

The increase in yield over a period of three years obtained from 2 cwt. dressing of surperphosphate was more than double that obtained from an equivalent amount of phosphoric acid in the form of basic slag, and nearly four times that obtained from an equivalent of bone fertilizer.

Water soluble phosphate has given the same marked increase over basic slag and bone fertilizer with irrigated lucerne, as it has over the same fertilizers with the wheat crop.

The quantitative test with superphosphate is of interest. Successive moieties of superphosphate up to 4 cwt.—the highest quantity used in the tests—have given increases in hay yield. These increases show a substantial margin of profit after deducting the cost of the fertilizer applied.

It is evident that a dressing of 4 cwt. of superphosphate (18 per cent. P_2O_5), which adds to the soil 80.6 lbs. of phosphoric acid, does not represent the limit for the profitable use of superphosphate under the conditions obtaining at Werribee.

As these fertilizer plots received equal quantities of water, it follows that the water cost of the dry matter produced would be lowest on those plots receiving the heaviest dressings of water soluble phosphate.

The effect of 30 cwt. of gypsum in addition to 2 cwt. of superphosphate is significant. For the three years' period the average increase due to the application of 2 cwt. of superphosphate was 18.5 cwt., worth 55s. 6d. per acre, with lucerne, at £3 per ton. Such increase was obtained at an extra cost of 14s., being the cost of the fertilizer and its application.

The addition of 30 cwt. of gypsum, costing an extra 37s. 6d. per acre, gave an increase of 33.1 cwt., worth 99s. 4d. per acre—obtained at a cost of 51s. 6d. for fertilizers.

The cost of the gypsum was paid by the crop and a substantial margin of profit resulted; but the action of the gypsum is likely to last for some years. The gypsum may be of value because of its effect in liberating potash, but it is more likely that its beneficial results are

due in the main to an improvement in the texture and porosity of the subsoil.

Applications of soluble potash salts have not resulted in any increase in lucerne yields at Werribee. On the other hand, a dressing of gypsum, supplemented by 2 cwt. of superphosphate, has given an average increased yield for three years of 33.1 cwt. of hay over the unmanured plot, and 14.6 cwt. over the plot treated with superphosphate.

The action of the gypsum is most probably due to its flocculating effect on the fine clay particles in the subsoil, which would result in improved texture, better drainage and increased aeration, all of which would make the conditions more favorable for crop growth and more rapid movement of water in the subsoil.

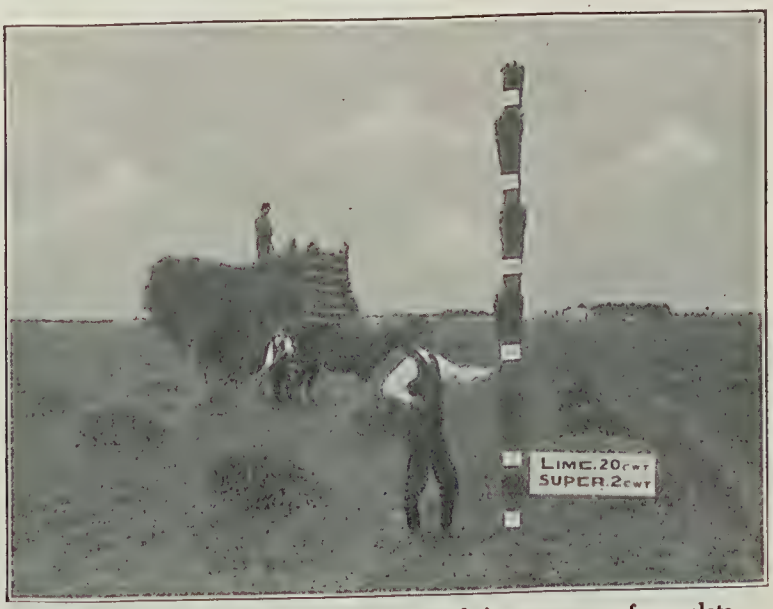


Fig. 39.—Lucerne pole, showing total growth in one season from plots treated with lime and superphosphate.

At the Leeton Irrigation Settlement, New South Wales, gypsum has been used as a top-dressing on lucerne with beneficial results, especially where lucerne has been planted on soils with stiff clay subsoils, or with a layer of hard pan in the subsoil.

The results obtained with gypsum at Werribee are of great importance to the irrigated areas. In the Goulburn Valley the soils are for the most part underlain by stiff clay subsoils which are more or less resistant to the free penetration of water and lucerne roots. If the texture of these clay subsoils could be materially improved by the use of gypsum, and the porosity thereby increased, the yield of lucerne would be increased and the water cost of the crop materially lowered.

Gypsum exists in enormous quantities as surface deposits in northern Victoria, and in a form of a dry powder which does not require any preparation prior to its application to the soil.

Should further experimental work with lucerne fields in the Goulburn Valley and northern irrigation settlements confirm the results

obtained at Werribee with respect to the use of gypsum supplemented by phosphates, there is every reason to believe that lucerne will become a most profitable and popular crop in the northern irrigated areas.

Acknowledgment.

Without the active co-operation of the officers of the Department of Agriculture, the carrying out of these investigations would not have been possible.

The writer desires to thank Messrs. A. M. Armstrong, C. Blazey, G. S. Gordon, and T. M. Whelan for assistance in recording weekly, and in some cases daily, losses by transpiration; Mr. R. G. Thomas for assistance in preparing data showing the relationship of wheat yield to rainfall, and Mr. L. C. Bartels for assistance in regard to the irrigation investigations. To Messrs. P. R. Scott and W. C. Robertson, of the Chemists' Branch, the writer is specially indebted for efficient aid in the chemical work involved throughout the investigations.

Harvesting Lucerne, State Research Farm, Werribee.

CONCLUSION AND SUMMARY.

The object of the investigations recorded in this paper was to determine, for Australian conditions, the amount of water required to elaborate a unit weight of dry matter for the principal farm crops and the influence of variety, season, varying moisture saturation, fertilizers, and physical environmental factors on the water requirements of crops.

The method adopted in studying the use of water by the crop was to grow the plants to that stage of maturity at which they are normally harvested in practice under controlled conditions in pots of sufficient capacity to allow normal plants to be grown.

The tests were conducted under field conditions at two centres—Werribee and Rutherglen—and under a glass pot culture house at Rutherglen.

The field tests were conducted for two seasons and the tests in the pot culture house for four seasons.

The pots used for the field tests were 15¾ inches in diameter and 27 inches deep, and held approximately 250 lbs. of moist soil. The pots used in the pot culture house were 9 inches internal diameter, 20.5 inches deep, and held 70 lbs. moist soil. In the field tests rain was not excluded. Evaporation from the soil was assumed to be equal to the evaporation losses from the bare fallow pots.

In the pot culture house rain was excluded and evaporation from the soil was reduced to negligible amounts by gravel mulches and the use of special subsoil watering devices. All field tests were conducted in duplicate and all tests in the pot culture house in triplicate. The water requirement determined under field conditions showed close agreement with the water requirements as determined in the pot-culture house during the same season.

1. The average Transpiration Ratio for farm crops at Rutherglen for a period of four years was:—Peas, 344; barley, 350; wheat, 380; oats, 390; mustard, 414; rye, 421; rape, 490; vetches, 593; lucerne, 790.5.

2. The average Transpiration Ratios for grain for four seasons was:—Peas, 673; barley, 926; wheat, 1,088; oats, 1,190; rye, 1,525.

3. The Transpiration Ratio is not a constant and definite quantity for any given crop, but it varies from season to season, and from locality to locality, due to natural climatic differences. It also varies with the period of the year during which the crop is grown.

4. A consistent relationship has been established between the Transpiration Ratio of a crop and the rate of evaporation from a free water surface during the period of maximum transpiration.

5. The transpiration rate increases exponentially during the early stages of a crop and reaches a maximum shortly after flowering. For winter-grown cereals, this period of maximum transpiration occurs in Australia during October. The period of maximum transpiration usually coincides with the combination of greatest heat, lowest humidity, and greatest wind velocity during the growing period of the crop. With winter-grown wheat no less than 40 per cent. of the total moisture used by the crop was transpired during October and over 80 per cent. from September to November, notwithstanding the fact that the period of growth extended over seven and a half months. Lucerne, at the flowering stage, transpired as much as 25 to 29 per cent. of its total water requirements within a three-day period. Hence the intensity of the physical environmental factors during this maximum transpiring period largely determines whether the Transpiration Ratio will be high or low.

6. High water requirements are associated with intense evaporation during the period of maximum transpiration. This intense evaporation represents the summation of the effects of high air temperature, low atmospheric humidity and wind velocity. Conversely low water requirements are associated with cool, humid, wind-still conditions during the period of maximum transpiration. As localities and seasons vary considerably with respect to the intensity of the physical environmental conditions during this period of heavy transpiration the Transpiration Ratios must necessarily vary.

Thus the average transpiration for cereals in a typical drought year at Rutherglen was 546 as compared with 273 for a favorable season.

A difference of 121 per cent. in the evaporation rate for the month of maximum transpiration and of 70 per cent. in the evaporation rate for the three months September to November, caused a difference of 100 per cent. in the Transpiration Ratio for the two seasons. A difference of 44 per cent. in the rate of evaporation during October, 1914, at Rutherglen and Werribee, caused a difference of 44 per cent. in the water requirement per pound of dry matter.

Summer-grown wheat at Werribee required 65 per cent. more water to produce a pound of dry matter than winter-grown wheat of the same variety. The rate of evaporation during the month of maximum transpiration was 69 per cent. higher with summer-grown wheat than the evaporation for the corresponding period with winter-grown wheat.

The water requirements of eight crops tested at Rutherglen over four seasons showed variations which corresponded very closely with the rates of evaporation during the period of maximum transpiration.

7. As we pass from the southern coast line of Australia to the interior—(*a*) Rainfall diminishes, (*b*) humidity decreases, (*c*) air temperatures increase, (*d*) evaporation rapidly increases. Hence crops raised in the arid regions are likely to suffer from the double disadvantage of shortage of rainfall and a high Transpiration Ratio.

8. The different varieties of wheat do not vary widely in regard to the quantity of water required to elaborate a unit of dry matter. They do vary considerably in the amount of water required to produce a unit weight of grain, because the proportion of grain to straw varies considerably with the variety. Thus with six varieties of wheat tested, the Transpiration Ratio for grain varied from 660 for Yandilla King to 1,188 for Kubanka. This point is of practical significance in the breeding of wheat varieties for arid areas. The migration ratio is a factor of importance in the creation of new varieties for arid localities, for this determines whether the variety will utilize the scanty water supplies economically or wastefully in the production of grain.

9. The Transpiration Ratio for wheat does not vary greatly with degrees of soil saturation, ranging from 30 to 90 per cent. of the water-holding capacity, but, on the whole, the water requirement for dry matter is greater in moist than in dry soil, and is lowest for soils maintained at moderate degrees of soil-saturation (45 per cent. of W.H.C.) The water requirement for grain, however, consistently and markedly increases as the degree of soil saturation increases, and the migration ratio rapidly diminishes with increasing soil humidity.

10. The application of artificial manures produced a marked lowering in the water requirement of wheat. The unmanured control plots showed a 29 per cent. higher water requirement than did plots treated with a normal dressing of complete minerals, and 39 per cent. higher water requirement than the plots treated with a heavy dressing of complete minerals. Nitrogen produced the greatest relative reduction in the Transpiration Ratio for dry matter.

When nitrates are available in abundance (as in well-worked fallows) the addition of a soluble phosphate not only increases the vigor of the crop, but materially lowers the Transpiration Ratio, and thus brings about a more effective utilization of soil moisture.

The effect of a suitable manure in aiding the plant to economize water supplies is an important factor in relation to the control of the Transpiration Ratio.

11. From a review of all the data, it is concluded that the absorption of mineral nutrients is independent of the absorption of water.

The composition of the soil solution is not constant, but is dependent on the mode of combination of the phosphoric acid and potash in the soil, and on the amount of nitrates present in the soil, all of which are affected by the fertilizer supply.

An increase in the density of the soil solution resulting from excess dressings of mineral nutrients was accompanied by an increase in the amount of mineral nutrients taken in by the plant per unit of water transpired, and by a material reduction in the Transpiration Ratio.

12. Transpiration is essentially evaporation of moisture from a wet leaf surface, and variations in temperature, humidity, and air movements, which increase or decrease evaporation, produce a similar effect on the plant.

The rate of transpiration depends on the moisture supply of the leaf and the evaporating power of the atmosphere, and this latter is a constantly fluctuating quantity owing to variations in temperature, humidity, and rate of air movement.

The rate of transpiration cannot therefore be regulated through the density of the soil solution, though the Transpiration Ratio may be materially reduced by liberal use of fertilizers.

13. The reduction in the Transpiration Ratio in a liberally manured soil is due to the more vigorous growth of the crop rather than to a reduction in the rate of transpiration, for on such soils the crop is increasing in dry matter in an economical manner throughout the whole of the time it is transpiring water. On the unmanured soil growth is retarded, but transpiration is continuous, so that the water cost of the dry matter produced is necessarily high.

Any factors which aid in the more perfect development of a crop—well tilled soil, use of appropriate fertilizers, good moisture supply, seeding of the crop under favorable conditions, good drainage and aeration—will enable crops to produce dry matter economically.

14. The composition of the crop is materially affected by the fertilizer applied. The most significant changes are caused by nitrogen. Heavy dressings of nitrogen greatly increase the nitrogen content both of the grain and the straw of wheat. The increase in the nitrogen content of the grain is accompanied by a marked reduction in the phosphate content, and a lesser reduction in the potash content.

The potash content of the straw is increased and the phosphate content reduced by heavy dressings of nitrogen.

15. The Transpiration Ratio of farm crops is profoundly influenced by the season. In a season of low annual rainfall, with hot, dry, windy weather at the critical period of maximum transpiration, a given crop will show a higher water requirement than in a season with cool, humid weather during the same period. The rate of evaporation from a free water surface during the period of maximum transpiration is an index of the water requirement of the crop.

A knowledge of the rate of evaporation from a free water surface is thus as important as a knowledge of the rainfall and its incidence in determining the suitability of arid lands for settlement.

16. The water requirement of lucerne is not constant, but varies with the locality, the season, and the period of the year at which it is grown.

17. The Transpiration Ratio for lucerne varied with the degree of soil saturation. At moderate degrees of soil saturation (60 per cent.) the water requirement was lower than with either extreme soil humidity (90 per cent. W.H.C.) or extreme dryness (30 per cent. W.H.C.).

18. In field tests the water cost of dry matter produced varied materially with the amount of irrigation water applied.

Lucerne produced dry matter at lower water cost with moderate irrigations (24 to 30 acre inches) than with either heavy irrigations or no irrigation.

19. The yield of lucerne varied directly, but not proportionally with the water supply up to the limit of 48 acre inches of irrigation water.

20. Superphosphate produced a marked increase in lucerne yields, and a marked lowering in the water cost of dry matter produced.

21. A lucerne crop yielding seven tons of dry matter per acre removed from the soil 65 lbs. of phosphoric acid, 321 lbs. nitrogen, and 348 lbs. of potash.

Lucerne, therefore, removes from the soil five times as much phosphoric acid, nine times as much nitrogen, and 36 times as much potash as a 30-bushel wheat crop.

22. The application of gypsum resulted in a substantial and profitable increase in the lucerne yield. The beneficial effect of gypsum is probably due, not to the liberation of potash, but to its effect in improving the texture and permeability of the subsoil

Increased aeration, better drainage, and more rapid movement of the subsoil water result, and the conditions for plant growth are improved.

The results obtained at Werribee suggest that the texture of the stiff clay subsoils in the northern irrigation districts could be greatly improved at relatively small cost by the application of liberal dressings of gypsum.

23. The Transpiration Ratio determined for wheat postulates that with moderate rainfalls, each inch of rain received during the growing period of the crop is capable of producing 3.54 bushels of wheat.

24. A close relationship has been found to exist between the average wheat yield of South Australia and Victoria and the average composite seasonal rainfall.

For the past decade South Australian farmers reaped .94 bushel, and Victorian farmers 1.09 bushels of wheat for each inch of seasonal rainfall.

As the average seasonal rainfall for the wheat belt of the two States is 11½ inches, the maximum possible wheat yield would be 40 bushels per acre for the two States.

25. In the Wimmera district, where cultural methods have greatly improved during recent years, the average yield for the past decade, expressed in terms of rainfall, is 1.43 bushels per inch of seasonal rain. For the past five years 1.68 bushels of wheat have been obtained for each inch of rain.

On the Longerenong Agricultural College farm an average of 3.5 bushels per inch of seasonal rain has been obtained during the past five years. On two private farms in the Wimmera yields of 3.48 bushels per acre and 3.6 bushels per acre have been obtained during the same period.

26. The production of new varieties of wheat to meet the requirements of a low transpiration rate opens up a field of vast possibilities. Earliness of maturity and high migration ratio are of great importance in the production of wheats for arid localities.

27. Hybridization is the most promising method of producing early maturing, prolific varieties, with high migration ratio. Early maturity and late maturity behave as a pair of Mendelian unit characters. Crosses made between wheats of high yielding and low yielding strains showed distinct segregation in the F_2 generation into high and low yielding variants.

Centgener tests with F_3 families showed that the high yielding variants gave an average increase of 25.2 per cent. over the corresponding families derived from low yielding segregates.

28. A fixed cross-bred barley obtained by crossing Pryor with Skinless showed in centgener plots a 29 per cent. increase, and in field plots a 28 per cent. increase in yield over the highest yielding parent.

29. Gallipoli wheat, a cross-bred produced by the writer by crossing Clubhead and Yandilla King, has given consistently higher yields in field tests than either Federation or Yandilla King, the two standard varieties of the wheat belt.

In this variety earliness of maturity, high migration ratio and high yielding capacity have been combined.

30. As unit characters in wheat are independently inherited in accordance with the Mendelian law, it is possible to associate in one variety any combination of desirable unit characters.

The mode of inheritance of certain botanical characters has been worked out, but the determination of the factors which compose the mosaic of prolificness, drought resistance and low water requirements remains to be determined. With the evolution of harder strains with low water requirements, new territories may be subjugated and the utilization of existing areas may be made more effective.

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PASSION FRUIT CULTURE IN VICTORIA.

(Continued from page 412.)

By J. Farrell, Orchard Supervisor.

XII.—Habit of Leader and Lateral Growths, and Mode of Producing Fruit Buds.

When the young vines are systematically tied up on the trellises, and growth commences in the spring, the leaders, aided by their tendrils, extend by creeping along the horizontal wires. At this time the advantage of good cultivation and manuring become manifest,

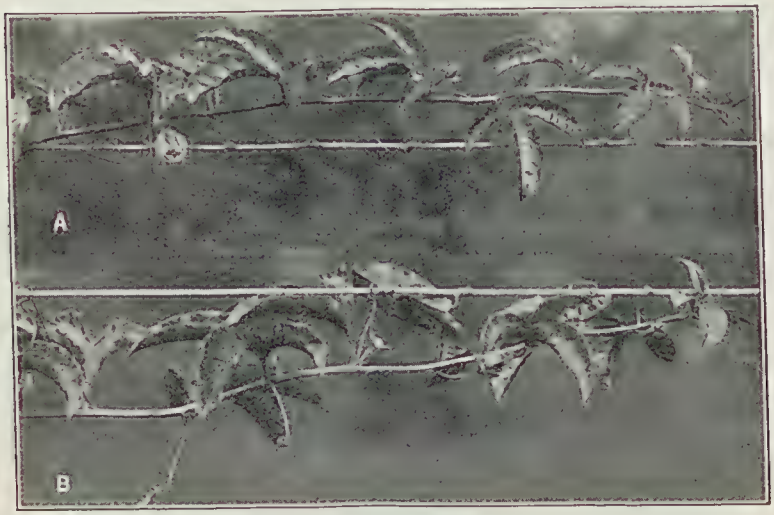

Fig. 25.—Habit of leader growth.

and as it is desirable to obtain the most vigorous growth possible, this condition should be maintained until the end of the growing period. Most other kinds of fruit trees that make early vigorous growth rarely come into bearing as soon as those of weak or normal development. This, however, does not apply in the case of the passion vine; on the contrary, vigorous growing young plants show the desired precocity, and continue to bear heavier and more consistently than less robust or weakly ones, and the fruit is larger and generally of better quality.

The sections of the two leaders, with their alternate lobed leaves, illustrated in Figure 25, are typical of these growths. The leader (A) is shown in the natural and comfortable position which these growths like to assume, "walking" along the wire, and in this way all the tendrils are utilized in clasping same. It will be understood that, while young, the tendrils are soft, pliable, and pendulous, coming early into contact with the wire, which they lay hold of as shown. Leader (B)

is in a less favorable position in relation to the wire from which it is suspended, and for the reasons explained, is deprived of the service of some of its tendrils. It generally happens, however, that the growing point of a leader like this gradually rises above the wire, and the further extension assumes a position like (A). The desirableness of obtaining the best method of lateral growth is a further reason for careful and systematic treatment of the vine at the tying-up, when the fan-shape may be established and its permanency secured.

When a vine is of prolific character, and growth commences in the spring, a high percentage of blossoms appear, but many of these do not set fruit. The blooms, as well as the tendrils, are produced singly, one flower and a clasper appearing in each leaf-axil, although often either or both may be missing. The blossoms and tendrils are produced during the currency of the growth of the yearling wood, and these rarely begin to appear until the leader or lateral, as the case may be, has extended beyond the fourth or fifth node from its base on the older wood. Although the leaders are fruitful while young, the laterals

Fig. 26.—A fruitful lateral.

are usually more prolific. This may be seen by comparing the present weaker condition of the yearling lateral and its apparent impending florescence depicted in Figure 26, with the more virile but less floriferous leader growths appearing in the immediately preceding illustration. Both lateral and leaders were taken from the same vine.

The leaders and laterals extend during succeeding years by continuous growth from the terminal buds, whereas the sub-leaders and sub-lateral growths come from buds formed in the leaf-axils, with the flowers and tendrils on the previous year's wood. A high percentage of these buds gives out relatively short growths, all of which are capable of yielding fruit. Now we more clearly realize the necessity of pruning, as in the case of other vines and fruit trees, to regulate their length and maintain the proper number of these growths. Owing to past neglect in this regard, the urgent necessity of pruning to obtain the highest number of fruits of the finest quality and to relieve the vines of the burden of supporting numerous, superfluous, willowy growths cannot be too frequently reiterated.

XIII.—Blooming, Pollination, Setting, Development, and Ripening of the Fruit.

The passion flower is so named because of a fancied resemblance of the parts of the flower to the instruments of Christ's crucifixion. The corona represents the crown of thorns, the stamens and pistils the nails of the cross, while the five sepals and five petals stood for the ten faithful apostles.

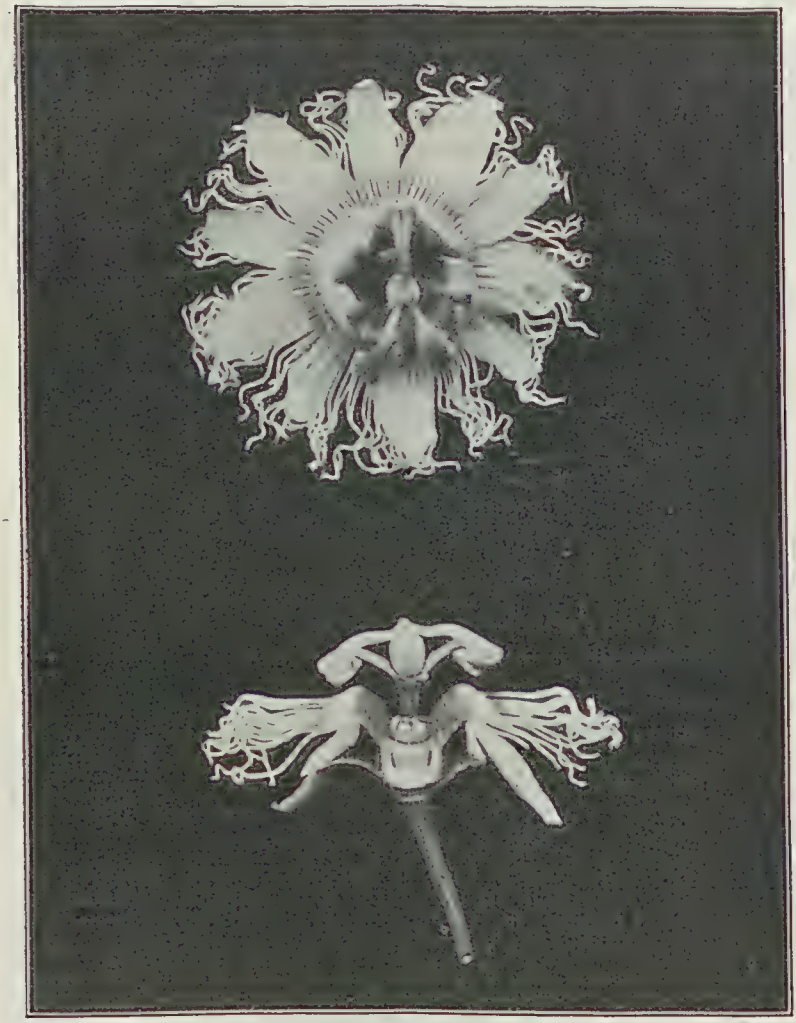

Fig. 27.—The Passion flower (*passiflora edulis*) natural size.

Weather and other conditions being favorable, passion vines produce two crops of fruit each year. The first crop ripens in February or March and the second during June or July. In some places, and

during certain seasons, however, cropping is almost continuous from February to July or August. Unpruned plants bloom sooner and ripen their first fruits earlier than pruned vines. The blossoms from which the early fruits mature usually appear in November, and those for the later crop in March or April. Now it will be seen that pruning, to a great extent, regulates the time of ripening, and consequently, marketing of the fruit. Early ripening passions and the last fruits of the season bring the highest prices on account of the scarcity of fruit at these times; whereas, lower returns are accepted for those ripening in the interim, when gluts sometimes occur.

The frontal view of the passion flower (natural size), illustrated in Figure 27, is typical of the variety under review, and the vertical section appearing under same further shows the botanical construction of the flower and the relation of its organs to each other. These illustrations fully serve the purpose for which they are intended; but the camera, although showing the tracery of this exotic beauty, fails to fully depict the delicate loveliness of its colour, shade and blend. The

Fig. 28.—Showing development of the fruit.

pistil is in three divisions, the stigmas of which incline towards, and come into contact with the partly revolving anthers, as shown in both illustrations, thus insuring perfect pollination. Bees like to frequent these flowers, and while in search of the nectar, they cause the anthers to swing round and brush the pollen, with which these are abundantly supplied, on to the stigmas. Up to the present, this variety has not shown any need for cross-fertilization, but, possibly, the introduction of pollen from the Mammoth passion, which is in every respect similar to the commoner passion, except that the plant grows stronger and produces larger fruits, would cause the setting of even heavier crops. The Mammoth is in itself a shy bearer, but we are not to infer from this that its pollen would be unsuitable for crossing with the common black. We have evidence of two varieties of pear trees, both of which were self-sterile, but when brought into contact with each other, both became highly fruitful through the influence of interpollination. When fertilization is successful, the outer organs of the flower dry up and

gradually shrivel, while the young egg-shaped fruit, as shown in the section, develops. Most of the flowers appear during the mild or warm weather; but, even in winter when the atmosphere is cold, crisp, and clear, many of these attractive flowers may be seen nestling among the green foliage.

Figure 28 illustrates four later stages in the fruit's development up to the time of ripening, and these are shown about two-thirds natural size. All the withered outer organs of the flower are still attached to the young fruit on the left, and the organs are more withered on the larger fruit next to this. The remains of the pistil have disappeared from the next fruit which is fully grown, and the fourth, ripe specimen, has practically shed the last shred of its original floral ornamentation. The fruit, on arriving at the ripe stage, should be picked off and marketed as soon as possible; if not, it commences to wilt, drop on

Fig. 29.—Shows lateral with three fruits matured—one at each consecutive node.

the ground and deteriorate in value. Although the contents of wilted fruit is the more palatable, retailers like to stock passion fruit before this condition is reached, because, when wilting commences it proceeds rapidly, and, when the demand is slow, the fruit often shrivels before it can be distributed; therefore, higher prices are obtained by the grower for fresh fruit.

The fruits may be produced at consecutive nodes, or alternately along a leader or lateral, and as many as ten or twelve appearing in the former order is of common occurrence in certain seasons when growing conditions are most favorable.

Figure 29 shows a lateral having ripened three fruits consecutively near its base, then several nodes missed, and blooming began again later in the season, as may be observed in the illustration; but these flowers dropped from their cups, a matter which will be further dealt with under the heading of "Sterility." Some laterals strike off from

the leaders at right angles to the trellis, and in this position have little or no support. These pendulous growths are usually less fruitful than those which follow the line of the trellis and find a hold for their tendrils. In reducing the number of laterals at the pruning, these should be the first removed.

Fig. 30.—A two-year-old Mammoth passion vine.

XIV.—The Mammoth Passion.

This sub-variety—which was probably evolved from *P. edulis*, and introduced from other States of the Commonwealth into Victoria—is now being fairly extensively planted here. While young, particularly,

it makes much stronger growth, and its leaves and fruits are one-third or more larger than those of the common passion. Its requirements in respect to climate and soil are similar to those of the latter. It is also propagated in like manner, and as regards planting, cultivation, manuring, pruning, &c., the best results accrue when these details are carried out on the lines previously explained. Up to last year (1922) neither the area under its cultivation, nor the duration of same, was sufficient to afford adequate data on which to warrant the recommendation of its permanent adoption. Some of the young vines planted here bear fairly well, but in many there seems an inherent tendency to shy bearing.

The Mammoth fruit is nearly round, large, and attractive, and when ripe its colour is also dark purple. On a few occasions in the past exceptionally strong growing plants, like the Mammoth, have been raised from the ordinary passion seeds. These made strong growth for a few years, and during that period produced large fruits. When growth became steadier and regular heavy cropping commenced; however, the characteristics of these vines in every respect reverted to those of the parent—*P. edulis.*

Several growers have planted out some Mammoth plants, mostly for experimental purposes, and as far as the experiments have gone, many have their doubts as to whether its cultivation will prove as profitable as that of the common black.

Figure 30 shows a two-year-old Mammoth vine, which, although having made good growth, is much less fruitful than the smaller black passions of the same age growing in the same garden. So far the Mammoth has proved highly resistant to pests and diseases; but, for the reasons mentioned, growers contemplating planting this variety extensively would be well advised to proceed cautiously and watch for the results of experiments already undertaken.

(*To be continued.*)

PROHIBITION OF REMOVAL OF BEES.

By a proclamation under section 4 (1) of the *Bees Act* 1915, dated 13th June, 1923, the municipal districts of Stawell (Borough), and Dimboola, Mount Rouse, Ripon, and Stawell Shires have been declared "Proclaimed Areas," and by regulations made under the same section, the bringing of bees into or the sending or removing of any bees, hives containing bees, used or second-hand hives, used or second-hand comb, or appliances from those areas has been prohibited, unless permission to do so has first been obtained.

Forms of application for permits may be obtained from the Chief Veterinary Inspector, Department of Agriculture, Melbourne.

BROWN ROT OF STONE FRUIT.

SPRAYING EXPERIMENTS.

Copy of Report by A. A. Hammond, Orchard Supervisor.

Bordeaux Mixture v. Lime Sulphur.

Last season further experiments were made in the value of spraying for the control of the brown rot fungus (*sclerotinia fructigena*). On

Condition of Twyford blooms when sprayed with Lime Sulphur (1 in 20) on 14th September.

this occasion experiments were conducted at Croydon, in the orchards of Mr. S. Hardidge and Mr. H. Smith.

The main object of the experiments at Mr. Hardidge's orchard was to determine the value of Bordeaux Mixture as compared with Lime Sulphur for the control of the disease.

Five trees in each of two adjoining rows in the centre of the cherry patch were chosen. The varieties chosen were Twyford Biggareau, Bedford Prolific (ten trees in each case), and Florence (two trees). The trees selected appeared to be an even lot in size and shape.

The Twyford is usually the most susceptible to the disease, but the Florence is also very subject to infection when rain falls just before harvesting time. The Bedford appears to be the least liable to the disease, and in the experiments under notice there was practically no disease observed in this variety.

Some of the trees received two spray applications, some three, and some four, and in some instances the Woburn Bordeaux Mixture was substituted for the Sulphur Casein spray, in order to ascertain, if possible, the relative efficiency of these sprays for the final application.

The outstanding feature of the experiments was the superiority of the Lime Sulphur spray as compared with Bordeaux Mixture.

Condition of Twyford blooms when sprayed with Lime Sulphur (1 in 25) on 28th September.

The blooms and fruit were carefully checked on trees 3 and 4 (Twyford). These trees were of about the same size and shape. No. 3 received three sprayings of Copper Sulphate solutions whilst No. 4 was treated with the Sulphur sprays on the same dates. The results are shown in the table herewith. Trees Nos. 9 and 10 (Florence) also showed the superiority of the Lime Sulphur over the Bordeaux Mixture. Both these trees were treated with Lime Sulphur in the first spray, but on the second spraying No. 9 was treated with Bordeaux and No. 10 was sprayed with Lime Sulphur. No disease was apparent in either of these trees early in November, but towards the end of the month it showed up badly in the one sprayed with Bordeaux on the 25th October, whilst the tree treated with Lime Sulphur on the same date was comparatively clean. The cherries from these trees were harvested on 12th December. On 9th December there had been 29 points of rain, and on 10th 17 points.

No check trees were left in this orchard, as Mr. Hardidge suffered so severely from the ravages of brown rot the previous season that he would take no risk. I may mention that Mr. Hardidge sprayed the whole of the cherry and plum trees in the orchard with Lime Sulphur and Sulphur Soda, his experience of Bordeaux in the previous year (1921) being most unsatisfactory. The results of his spraying

Condition of Burgdorf blossoms when sprayed with Lime Sulphur (1 in 20) on 22nd September.

in the past year (1922) were entirely satisfactory, his loss being less than 10 per cent. as compared with 50 per cent. of the previous year.

The Best Time to Spray.

In the experiments carried out at Mr. H. Smith's orchard, at Croydon, the Lime Sulphur spray only was used. The main purpose of these experiments was to ascertain the best time to apply the first spray.

Some trees were sprayed when about 10 per cent. of the blooms had opened, some when 50 per cent. had opened, and others when the trees were in full bloom. In the case of an Early Purple Guigne, which was sprayed with Lime Sulphur (1 in 20) on 14th September when in almost full bloom, no trace of burning was noticeable. Burgdorf's Seedling and Black Biggareau sprayed at the same strength a week later, when in about the same condition, showed evidence of burning, the petals turning brown. A light crop set on the trees, which showed burning.

It was remarkable, however, that a Burgdorf's Seedling left as a check was rather badly affected with the brown rot fungus, while the sprayed trees were almost free from disease. The Burgdorf's were sprayed with Lime Sulphur (1 in 20) on 22nd September. The trees next the check tree were examined on 5th October and compared with the check tree. On the unsprayed tree 70 blooms were diseased. The blooms on the two trees next the check tree were examined, and on

Cherry Blossoms affected with Brown Rot Fungus.

one two blooms were diseased and on the other no affected blooms could be found. On 22nd November, just before picking, the trees under notice were again examined. On the check tree 28 diseased cherries were found. On the sprayed trees the whole of the fruit was quite free from disease.

The results obtained from the trees first sprayed, when 10 per cent. of the buds had expanded, were as good as those from the trees to which the first application was made, when 50 per cent. of the blooms had opened.

As mentioned previously, Lime Sulphur used on Burgdorf's at a strength of 1 in 20 caused burning. A mixture of 1 in 25 sprayed on

Twyford's a week later, when half the blooms had opened, did not cause the slightest injury.

The result of the experiments would seem to indicate that the best time to apply the first spray is when about 10 per cent. of the blooms have expanded, but if rain threatens, it is better to defer the first application, and to spray immediately the weather becomes fine.

The Sulphur Casein and Woburn Bordeaux sprays mentioned above were made in accordance with directions given in this *Journal* of March, 1922. Commercial Lime Sulphur .33 deg. Baumé was used throughout. The Bordeaux Mixture was made from Macclesfield bluestone and good lump lime.

Although in the previous season's experiments no appreciable difference could be observed between the results from trees sprayed with Bordeaux and Lime Sulphur, the results of the experiments at Mr. Hardidge's orchard proved the superiority of the Lime Sulphur as a spray for brown rot.

TABLE OF SPRAYING EXPERIMENTS FOR THE CONTROL OF BROWN ROT IN CHERRIES, CONDUCTED AT MR. S. HARDIDGE'S ORCHARD, CROYDON.

Tree Number and Variety.	Mixture used.	Strength.	Date of Application.	Number of blooms affected.	Number of fruits affected.	Percentage clean fruit harvested and quantity in lbs.	Remarks.
(1) Twyford	Bordeaux ..	6.6.40	Sept. 14 Nov. 8	Not counted	545	44 lbs., 88.9	About 10 per cent. of flower buds open on 1, 2, 3, and 4
(2) Twyford	Lime Sulphur	1 in 10 1 in 11 1 in 32	Aug. 15 Sept. 14 Oct. 25	Not counted	263	22 lbs., 89.3	Small tree
	Woburn Bordeaux	..	Nov. 8				
(3) Twyford	Bordeaux ..	6.6.40 3.3.40	Sept. 14 Oct. 27	134	725	33 lbs., 81.9	Nos. 3 and 4 trees much alike in every respect
	Woburn Bordeaux	..	Nov. 8				
(4) Twyford	Lime Sulphur	1 in 11 1 in 32	Sept. 14 Oct. 25	65	103	55 lbs., 98.1	
	Sulphur Casein	4 to 40	Nov. 8				
(5) Bedford	Bordeaux ..	6.6.40 3.3.40	Sept. 14 Oct. 27	Not counted	..	..	Showed very little disease
	Sulphur Casein	4 to 40	Nov. 8				
(6) Bedford	Lime Sulphur	1 in 11 1 in 32	Sept. 14 Oct. 28	...	..	..	Negative results, there being no disease showing of any consequence
	Woburn Bordeaux	..	Nov. 8				
(7) Bedford	Bordeaux ..	6.6.40	Sept. 14	...	..	..	The result of spraying. Negative in 7 and 8. No disease showing
	Woburn Bordeaux	..	Nov. 8				
(8) Bedford	Lime Sulphur	1 in 11	Sept. 14				
(9) Florence	Lime Sulphur Bordeaux ..	1 in 20 3.3.40	Sept. 14 Oct. 25	No infected blooms noticeable	402	55 lbs., 94.2	
(10) Florence	Lime Sulphur	1 in 20 1 in 32	Sept. 14 Oct. 25	No infected blooms noticeable	61	44 lbs., 98.6	

POULTRY FEEDING EXPERIMENT.

W. C. Rugg, Poultry Foreman, State Research Farm.

An experiment to test the advisability of allowing birds free access to food at all times as compared with the ordinary practice of feeding at regular intervals, was conducted at the State Reseach Farm, Werribee, during the twelve months ended the 31st March last.

Seventy-two White Leghorn pullets, each of quality about equal to that of an ordinary farm flock (none of the birds chosen was from a single mating) were divided into two lots of 36 each, and each pen was given food of the same ingredient throughout the year.

Food Used.

The birds in both pens were given dry mash in hoppers which were open at all times. This mash consisted of—bran and pollard, equal quantities by measure; meat meal, 10 lbs. to every 100 lbs. of bran and pollard, and about 3 per cent. powdered charcoal. In addition, a grain mixture of three parts Algerian oats to two parts wheat was fed to each pen.

To No. 1 pen the grain was fed in a hopper always open, and the birds were allowed green stuff, whole not chaffed, from a wire basket which was kept well supplied.

The birds in No. 2 pen had their grain scattered in the litter and chaffed green-stuff was fed them at mid-day.

In order that the results might approximate to those that would have been obtained had the experiment been conducted on an ordinary farm, no other feed than that mentioned, which is obtainable almost anywhere in the State, was given the birds. A variety would have been greatly relished by them, and would probably have increased the egg-production, but as oaten pollard, barley, pollard pea-meal, bullocks' livers, &c. are not easily procurable by a large number of settlers at a distance from the metropolis, none of these were fed to the birds.

The green-stuff used was green barley, rye grass, and rape during the winter months, and lucerne all the summer. Minced raw onions were fed once a week—about three-quarters of a lb. to each pen. Epsom salts and sulphur were used when thought advisable. Shell grit and granulated charcoal were always available, and a dust bath was provided in each pen.

Housing.

The birds were housed in a corrugated iron shed facing east. Each pen had a floor space of about 260 square feet—a little over seven square feet to the bird—and they were kept in the pen throughout the test, no outside run being made available. The floor was covered with from 4 to 6 inches of litter. Droppings boards were used underneath the perches.

Health of the Birds.

The general health of the birds was good throughout the test.

In No. 1 pen (continuous feeding) one bird became blind, and two went light; these three were destroyed.

In No. 2 pen one bird was found dead, one died from crop trouble, and one contracted disease and was destroyed.

Food Consumed and its Cost.

—	Pen No. 1.—Continuous Feed.			Pen No. 2.—Regular Feeding.		
	Quantity.	Price.	Value.	Quantity.	Price.	Value.
		s. d.	£ *s. d.*		*s. d.*	£ *s. d.*
Bran ..	16¾ bus.	1 10 per bus.	1 10 8½	17½ bus.	1 10 per bus	1 12 1
Pollard ..	28 bus	1 10 per bus.	2 11 4	29½ bus.	1 10 per bus.	2 14 1
Meat Meal	88 lbs.	0 2 per lb.	0 14 8	93 lbs.	0 2 per lb.	0 15 6
Oats ..	22¾ bus.	4 0 per bus.	4 11 0	28 bus.	4 0 per bus.	5 12 0
Wheat ..	12⅓ bus.	6 2 per bus.	3 16 0½	12½ bus.	6 2 per bus.	3 17 1
	..	..	13 3 9	..	..	14 10 9

Eggs Produced and Their Value.

Month.	Price of eggs per doz.	No. 1. Pen.—Continuous Feed.				No. 2 Pen.—Regular Feeding.			
		Number of Birds.	Eggs laid.	Value.	Production per Bird.	Number of Birds.	Eggs laid.	Value.	Production per Bird.
1922.	*s. d.*			£ *s. d*	£ *s. d.*			£ *s. d.*	£ *s. d.*
April ..	2 6	36	337	3 10 2½	0 1 11·4	36	283	2 18 11½	0 1 7·6
May ..	2 9	36	405	4 12 9¾	0 2 6·9	36	191	2 3 9½	0 1 2·6
June ..	2 2	36	500	4 10 3¼	0 2 6·1	36	385	3 9 6¼	0 1 11·2
July ..	2 4	36	514	4 19 11¼	0 2 9·3	36	509	4 18 11¾	0 2 9
August ..	1 4	35	642	3 11 4	0 2 0·4	36	662	3 13 6¾	0 2 0·5
September	1 4	33	706	3 18 5¼	0 2 4·5	36	690	3 16 8	0 2 1·5
October	1 3	33	717	3 14 8½	0 2 3·1	34	687	3 11 6¾	0 2 1·2
November	1 2	33	567	2 15 1⅔	0 1 8	34	562	2 14 7¾	0 1 7·2
December	1 3	33	547	2 16 11¾	0 1 8·7	33	491	2 11 1¾	0 1 6·6
1923.									
January	1 5	33	482	2 16 10¾	0 1 8·6	33	540	3 3 9	0 1 11·1
February	1 7	33	352	2 6 5¼	0 1 4·9	33	392	2 11 8½	0 1 6·9
March ..	1 10	33	345	2 12 8½	0 1 7·2	33	279	2 2 7½	0 1 3·5
	..	34⅙	6,114	42 5 10¼	1 4 7	34⅔	5,671	37 16 11	1 1 8·9

Summary.

Egg Yield and Feed Cost.

—	Average No. of eggs per Bird.	Return per Bird.	Cost of Feed.			Profit over Cost of Feed.
			Mash.	Grain.	Total.	
		£ *s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
No. 1 Pen (continuous feed)	179	1 4 7	= 2 11·2	= 4 9·4	= 7 8·6	= 16 10
No. 2 Pen (Regular feeding)	164	1 1 8·9	= 2 10	= 5 6·6	= 8 4·6	= 13 0½

It will be seen that the birds in No. 1 pen which had their food before them continuously throughout the twelve months, produced the largest number of eggs and showed the highest profit per bird. They made their greatest gain during the winter four months, April 1st to July 31st, the time at which eggs bring the highest price in Victoria.

During this period they cost a little over 4d. per bird more for feed, but returned about 2s. 3d. per head in value of eggs as shown in the following table.

Egg Production and Feed Cost, April 1st to July 31st.

Pen.	No. of Eggs.	Value.	Cost of Feed.		Total.	Profit over Feed.
			Mash.	Grain.		
		£ s. d.			£ s. d.	£ s. d.
No. 1. Continuous	1,756	17 13 2¾	(318 lbs.) £1 11 3	(795 lbs.) £4 0 4½	5 11 7½	12 1 7¼
No. 2. Regular ..	1,368	13 1 3	(330 lbs.) £1 12 6	(670 lbs.) £3 7 9	5 0 3	8 1 0

One of the conclusions to be drawn is that pullets when starting to lay require more food than is usually given to them in early winter, as although the birds in No. 2 pen had a dry mash hopper always open and as much grain in the evening as they would pick up, those in No. 1 pen where food was always available consumed 113 lbs. more mash and grain for the four months.

The green feed was not weighed to the birds. It was noted that the birds in No. 1 pen consumed the greater quantity of this—a considerable amount of it just before going to roost—and although their basket was kept well supplied with fresh green-stuff (whole) every day, they would eat almost as much chaffed green-stuff at mid-day as the members of No. 2 pen which were given as much as they would pick up.

It is reasonable to conclude that this green-stuff taken by the birds in No. 1 pen the last thing at night, on an almost full crop of mash and grain, was an aid to digestion, and probably was an important factor in the higher egg-production.

Food Prices.

As most of the food used was grown on the farm, and the balance purchased in large quantities at wholesale rates, it was considered advisable to calculate cost of food on prices which were supplied by one of the leading poultry farmers in the State; they are as follows:—bran 1s. 10d. per bushel; pollard 1s. 10d. per bushel; oats 4s. per bushel; wheat 6s. 2d. per bushel.

Meat meal cost 2d. per lb.

Green-stuff was not taken into consideration.

MAIZE FEEDING EXPERIMENT.

It is the opinion of a number of people who keep poultry, that maize can be fed with safety only in the winter months, and that it is dangerous, or at least harmful to use it in summer.

To test the effect of feeding a high percentage of maize throughout the year, 36 birds of equal quality to those used in the above-mentioned experiment were housed in the same building and treated in an exactly similar manner except for the feed ration. This test, too, was for a period of twelve months. The birds in the pen were fed on dry mash, in hoppers always open, which was composed of maize meal, bran, and pollard, equal quantities by weight, to every 100 lbs. of which was added 10 lbs. of meat meal, and 3 lbs. of charcoal (powdered).

The grain ration which was scattered in the litter, consisted of three parts crushed maize and one of wheat. Chaffed green-stuff was fed at mid-day. There were three deaths; one bird went light and was destroyed in October; one was found dead in December; and one died of crop trouble in January. None of the complaints in these cases could be attributed to the maize. Otherwise the health of the birds was good throughout the year.

Food Consumed and its Cost.

Food.	Quantity.	Price.	Value.
		s. d.	£ *s. d.*
Maize Meal	16½ bushels	2 4 per bushel	1 18 6
Bran	16½ bushels	1 10 per bushel	1 10 3
Pollard	16½ bushels	1 10 per bushel	1 10 3
Meat Meal	99 lbs.	0 2 per lb.	0 16 6
Crushed Maize	24½ bushels	6 0 per bushel	7 7 0
Wheat	7½ bushels	6 2 per bushel	2 6 3
			15 8 9

Eggs Produced and Their Value.

Month.	Price of eggs per doz.	No. of Birds.	No. of eggs laid.	Value.	Production of Birds.
1922.	*s. d.*			£ *s. d.*	£ *s. d.*
April	2 6	36	326	3 7 11	0 1 10·6
May	2 9	36	285	3 5 4	0 1 9·8
June	2 2	36	422	3 16 2	0 2 1·4
July	2 4	36	463	4 10 0	0 2 6
August	1 4	36	526	2 18 5	0 1 7·5
September	1 4	36	579	3 4 4	0 1 9·5
October	1 3	35	625	3 5 1	0 1 10·3
November	1 2	35	562	2 14 8	0 1 6·7
December	1 3	34	487	2 10 9	0 1 5·9
1923.					
January	1 5	33	398	2 7 0	0 1 5·1
February	1 7	33	391	2 11 7	0 1 6·8
March	1 10	33	372	2 16 10	0 1 8·6
		34 1/12	5,436	..	1 1 4

Summary.

Egg Yield and Feed Cost.

Average Number of eggs per bird.	Return per Bird.	Cost of Feed.		Total.	Profit over Cost of Food.
		Mash.	Grain.		
	£ s. d.	s. d.	s. d.	s. d.	s. d.
156	1 1 4	3 3·6	5 6·5	8 10·1	12 6

The result of this experiment tends to show that maize fed in conjunction with other foods can be used with safety at all seasons of the year.

As maize is now being grown in larger quantities each year in many parts of the State it is probable that it will prove economical as a grain food in districts in which it can be procured at a reasonable price.

The fact that these birds did not suffer in any way is reflected by their egg-production for the last two months of the test. A reference to the table of egg-production of the several pens shows that the maize-fed pen produced, during the months of February and March, five and a half dozen eggs more than the No. 1 pen (continuous feed), and seven and three-quarter dozen eggs more than No. 2 pen (regular feed).

POULTRY NOTES FROM THE RESEARCH FARM.

(By W. Pederick, Poultry Foreman.)

There has been a heavy demand from the public for eggs for hatching purposes.

Hatching operations at the Farm are now in full swing. About 600 chicks were hatched in July, and are now doing well in the brooder house.

All chickens are hatched in pedigree trays and toe marked; this entails extra work, but is the only way of keeping an accurate record of the breeding of every bird reared on the Farm.

August is the busiest month for hatching, and the incubators are now full.

The fertility so far has been good, particularly so with White Leghorns, which is not usual so early in the season, especially when the weather is so cold and wet.

The chickens already hatched appear strong and healthy, and there is every prospect of a successful season.

Eggs required for hatching purposes are kept in a room of even temperature and away from strong light. When it is desired to hold them for more than a week before placing in the incubator they are placed in shallow boxes on chaff and turned once a day.

The hens in the breeding pens are not forced for egg production, but are fed a good plain mash in the morning, chaffed green stuff at midday, and at night a mixture of good grain, Algerian oats, wheat, and crushed maize.

A keen eye is kept on the male bird to see that he does not lose condition and that he is bright and active at all times.

With the approach of warmer weather it is necessary to keep a close watch on the birds for vermin. A good dust bath is very much appreciated by the birds and helps them to get rid of vermin. Perches and nests should be frequently examined for mites; if any are found, the perches, &c., should be either sprayed with kerosene or sprayed with a good disinfectant.

Although the weather has been very cold and wet since May, the pullets in the single test pens have laid well.

For the winter test, from April 1st to July 31st (122 days), the leading Black Orpington pullet laid 102 eggs, and the six leading Orpington pullets have laid 598 eggs, or an average for the 122 days of 99⅔ eggs per bird. The leading White Leghorn pullet has laid 94 eggs and the six leading White Leghorn pullets 534 eggs, or an average of 89 eggs for the 122 days.

A NEGLECTED MARKET FOR OUR WINES.*

By F. de Castella, Government Viticulturist.

The object of the present paper is to point out how little has been done in the direction of supplying the Australian public with cheap, sound, light wines for every-day use—something after the style of the *vin ordinaire* of France and of the great Latin wine-growing countries; to point out the vast potentialities which lie in this direction; and to submit a few suggestions as to how this neglected branch of our wine industry can, even at this late stage, be developed and placed on a firm footing.

Just over two years ago, when the Wine Congress was held in Adelaide, this phase of the question was referred to by the *South Australian Register*, in its issue of 19th May, 1921, in the following terms:—

> "The advice that Australians should drink more wine and less tea is all very well in its way, but—quite apart from the relative nutritive values—the question of cost operates against a general substitution of the one beverage for the other. Wine of the existing character and at the existing prices must necessarily remain a luxury rather than a necessity in the average middle-class Australian household, and, if vignerons wish to see it approximate more nearly to a national beverage here as it is in France, they should consider the problem of providing a lighter and cheaper article—without, of course, seriously impairing the quality which has made Australian wines famous abroad."

We have here the crux of the whole question. Wine is not a popular beverage with us for the simple reason that it is too dear. Even a well-to-do householder cannot afford to place wine on the table, as an every-day beverage, at the cost of three or four shillings per bottle, any more than the French householder could supply his family with expensive clarets or burgundies every day of the year.

* Paper read at the Fourth Australian Wine Congress, Sydney, June, 1923.

I do not mean to say that the prices our vine-growers receive for their wines are too high—far from it. Under present circumstances it is difficult to see how wines of the type and quality we now bottle could be profitably sold any cheaper. Value for value, they compare most favorably with the wines of any other country in the world. What I want to point out is that there is another type of wine, practically unknown in the Commonwealth yet, which can be made available at a far cheaper price, and that in the providing and popularizing of this type there are possibilities for the expansion of our wine industry to an extent undreamt of by the most sanguine well-wishers of the Australian vine.

In the evolution of our wine industry we have taken as models the choicer and more expensive wines of old European countries. In other words, we have disdained the lower rungs of the ladder; we have made a start rather more than half-way up. We have, it is true, achieved remarkable success in the quality of the wines we now produce, but we have failed to make Australia a wine-drinking country; we have failed to make our industry of truly national importance, as are the wine industries of France, Italy, and Spain, and likewise of such South American States as Argentina and Chile, where, as with us, climate and soil favour the vine, and yet it is these neglected bottom rungs which alone can enable viticulture to achieve truly national importance.

Retrospective.

James Busby foresaw, nearly 100 years ago, in 1825, the great future in store for Australian viticulture; his optimism concerning it was as marked as his pessimism in regard to other rural industries. Examining the circumstances of the colony of New South Wales, to which he was about to emigrate, and the relation in which it then stood to the Mother Country, he describes it as being "Destitute of, or producing in a very inconsiderable degree, any article of produce which might minister to the wants or comforts of Great Britain, and, consequently, incapable of maintaining with her that regular and natural intercourse between a colony and its parent State, which consists in the exchange of the raw produce of the one, for the manufactured commodities of the other." He explains that Australia, as it has since been called, was looked upon " rather as a necessary and expensive appendage to the judicial institutions of the country, than a colony to which she might look for an extension of her power, or an increase of her trade and resources." . . . " Agriculture has been said to be the natural and proper business of all new colonies." but, he pessimistically adds, " the situation of the colony of New South Wales has been unfavourable for the exportation of the surplus produce of those articles to the raising of which its agricultural industry has, hitherto, been confined." Cereals, and even wool-raising, offered, in his opinion, but little hope. Far different are his views on wine production. He explains how, " from a consideration of these circumstances, and under a strong impression of the importance to the colony of an increase of its exportable commodities," he spent some months in the best wine districts of France learning the cultivation of the vine and inquiring to what extent it might be profitably grown in New South Wales. The result was " a conviction on his mind that there was the strongest probability, not of its partial success, but of its supplying the great *desideratum* of a *staple article of export*, to which the

colonists of New South Wales might be indebted for their future prosperity."

"This conviction was founded, in the first place, on a consideration of the profits derived from the cultivation of vineyards (in France); the value which this culture gives to lands favorable for it over those employed in any other species of agriculture, and its importance in the rural economy of countries where it is most generally and extensively established; in the second place, on the probability that the climate of New South Wales, and many of its soils, at present useless from their sterility, would be favorable for the culture of the vine; and, in the third place, on its being a culture for the products of which an extensive market might be found."

Numerous examples are given of the results achieved by viticulture in various parts of France. "It would be superfluous to prove," he continues, "that an extensive and profitable investment for capital and labour would increase the resources of the colony and, consequently, its intercourse with Great Britain; . . . . present a more extended and increasing market for her manufactures; and that the bond of union between the colony and the Mother Country would be strengthened," &c.

Sixty years after Busby wrote thus, was held, in London, the Colonial and Indian Exhibition—in 1886. My late father wrote, for that occasion, a little book, descriptive of some phases of Victorian viticulture, entitled *John Bull's Vineyard*, a title borrowed from Max O'Rell, and which, let us hope, is prophetic. It is, indeed, becoming so, and it is fitting to here recall the names of Burgoyne, Pownall, Smith, Gilby, and others, who have brought our trade with the Mother Country to its present dimensions.

May I be pardoned a couple of brief quotations from my father's little book? In the introduction he excuses the borrowed title—"We have to speak of matters new and of moderate interest, of unknown wines; and this to John Bull, who hates anything new, especially in the shape of liquors; our only chance is to appeal to his practical qualities. . . . . If we can only cause him to observe that he has properties which he has hitherto neglected—vineyards in Australia, most valuable vineyards, which may bring him money and health, two things he is very fond of—the day is ours."

Federation was then a distant dream, but my father already deplores (p. 170) the Customs barriers between the Australian colonies, as they were then called, which imposed duties of 5s. and 6s. per gallon on wine, benefiting nobody and hindering the industry and constituting "the greatest obstacle to improvement in Australian vintages. . . ."

"Take away the intercolonial duty, a field three times as large is opened to every one, and they can all compete for the favour of an extended public."

"Wines, like works of art, require to be compared with one another. It is only when the intercolonial duty on Australian wine shall have been removed—when the growth of the various colonies can be placed side by side to establish Australian reputations—that the industry may be expected to advance, in the colonies first; outside, perhaps, afterwards. We hear of a possible federation of the British Empire. No doubt it will come some day. The free introduction into John Bull's Dominions of John Bull's pure wines of low strength would be, we imagine, amongst all other commodities, that which would be

the greatest boon to the greatest number, at the same time that it would cause the less comparative diminution in the receipts from Customs duties."

"High-class foreign wines, consumed by the 'upper ten,' will continue to be imported. It would be to those who drink at present little or no wine, and consequently pay no duty, that the free trade of British light wines would be a welcome change."

It is noteworthy that it was not long after the 1886 Colonial and Indian Exhibition that the London market commenced to absorb an important part of our wine production. Good progress has undoubtedly been made, but much remains to be done. For recent fluctuations the war and its aftermath are, of course, to blame. These are only temporary and will soon be remedied, but the pre-war expansion of our trade with the Mother Country was all too slow. John Bull has, as yet, only partially awakened to the existence of his Australian vineyard —he drinks only a quarter of a gallon (.27 to be accurate) of wine from all sources per annum. The coming Empire Exhibition should provide the opportunity to entirely awaken him, thus completing the task commenced nearly forty years ago, so that we may, in fact as well as in name, become truly John Bull's vineyard.

Nearly a century has passed since Busby outlined our viticultural destiny. Progress has certainly been made, and an important industry established, but we have advanced all too slowly—too timidly. We produce ten million gallons a year, of which the United Kingdom took, in 1920-21, rather over a million gallons.

And yet we consume only half-a-gallon per head of population. It is here that lies our biggest opportunity. Here is the market which is capable of almost indefinite expansion, if we only go about it the right way. This market must be expanded before we can look upon ourselves as a really viticultural country.

Importance of the Home Market.

The world produces, roughly, 3,000,000,000 gallons of wine annually. Of this total the Latin nations of Europe, France (including Algeria), Italy, and the Iberian Peninsula, contribute no less than 2,640,000,000, leaving only 360,000,000 gallons for the rest of the world. The Latin vintage represents six-sevenths of the world yield, and France, including her African colonies, contributes about half the Latin contingent, or about three-sevenths of the world's annual vintage.

France is thus easily the foremost viticultural nation, and her choice wines are household words the world over. She is the greatest wine-exporting nation. Yet, what is her export trade in proportion to her total wine production? For a good many years in the pre-war period it fluctuated in the neighbourhood of 4 or 5 per cent. Last year the export proportion was considerably less, owing to reduced shipments (only 26,000,000 gallons); and the enormous vintage of 1,760,000,000 gallons was gathered; export thus amounted to about $1\frac{1}{2}$ per cent. of the total wine crop.

Similar figures might be quoted for Italy and Spain. In all these countries it is the home market that absorbs almost the totality of the wine grown annually; only a tithe is exported. So must it be in Australia before we can fulfil our viticultural destiny.

We must, however, make one important reservation—shipments to Great Britain should not be classed as exports. To supply the Mother

Country with the wines she cannot grow herself is surely not exportation any more than is the sending of Algerian wines to their mother France.

The sea carriage is much longer in our case; but Australia is as much to Britain as Algeria is to France. Britain has been able to go further afield—that is all—owing to the wider range of her "sail-stretched wings."

Vin Ordinaire.

An examination of what this enormous wine consumption of the Latin countries consists of is interesting. The preponderant part of it is *vin ordinaire*, a type which is almost an unknown quantity to the average Australian or Englishman who has not resided in France, Italy, or Spain, and who only knows the wines of these countries by the type exported—clarets, burgundies, champagnes, ports, sherries, &c.

In Latin Europe, wine is not a luxury, but one of the daily necessaries of life, figuring on the table as an integral part of the mid-day and evening meals of rich and poor, as well as in hotels and restaurants, where it is not charged for any more than bread or tea are in Australia.

In wealthy homes choice wines are served occasionally, but *vin ordinaire* is the family beverage which appears every day on the table.

In these countries wine is not consumed to any extent between meals, but a meal is not considered complete without a glass or two of wine. Taken regularly in this way, it is a food and not a stimulant—it forms part of the daily ration, replacing an isodynamic quantity of other carbohydrates. Though consumed very generally, it is always taken in strict moderation, and very often, especially in summer, it is diluted with water.

Space will permit only the briefest reference to the relation between light wine and temperance—the general sobriety of the people in Southern France and other wine-drinking countries is proverbial. Alcoholism is unknown in the regions of abundant light wine. There is no temperance question in Southern France because there is no intemperance. Alcoholism has given cause for alarm in Northern France, where the large beet-root distilleries are situated, but not in the vine-growing districts—it is noteworthy that the slogan of reformers is *Le vin contre l'alcool* (wine *versus* alcohol).

For it to be possible for wine to occupy such a position in the daily life of a nation, two things are necessary—the wine must be of low alcoholic strength, and it must be available at a price which will place it within the reach of all. Both requirements are met in *vin ordinaire*.

Official figures concerning the strengths of French wines are instructive. Those for 1907 vintage may be quoted—there has been little change since. In that year the total production of France was 1,453,564,000 gallons (Algeria excepted), classified as follows:—

	Gallons.
Wine of less than 19½% proof (11°)	1,296,372,000
Wine of 19½% proof	116,999,000
Wine of more than 19½% proof	40,000,000

In that year the quantity of sweet wine made in France amounted to only 712,000 gallons!

In pre-war times the usual average value of the wine vintaged in France was in the neighbourhood of 20 francs per hectolitre, or nearly 9d. per gallon, at which figure viticulture paid well.

In years of over-production, this price was sometimes reduced by more than 50 per cent. Prices such as these are rendered possible by two factors, viz., heavy yields and rapid maturation.

The *Midi*—Hérault and the three adjoining departments—has long specialized in the production of this class of wine. Deep, fertile soils are planted with heavy-bearing sorts, such as Aramon, Carignane, the Bouschet, hybrids, &c., and manuring is practised to an extent unknown in the less-productive vineyards yielding choicer wines. Intense culture is the watchword, and yields of 1,000 gallons per acre are quite common.

Aramon, which is one of the heaviest-bearing vines known, yields, in some favoured spots, more than 3,000 gallons per acre: A peculiarity of the wine made from such grapes is that it is fit for consumption when a few months old. Lengthy maturation of necessity increases the price of a wine; dispensing with it permits it to be sold cheaply. Unlike choicer wines—clarets, for example—which need wood and bottle age to acquire the quality they are capable of developing, *vin ordinaire*, which constitutes the bulk of the wine of France, is almost immediately fit for consumption, and improves little, if at all, on keeping—it is usually at its best at twelve months old.

Wines of this type, both red and white, naturally possess but little bouquet, but they have a briskness and freshness which renders them attractive to the regular consumer. They are thirst-quenching in a high degree, especially when diluted with water, and are, as a general rule, faultlessly made and in excellent condition.

Their high acidity at first seems strange to an Australian, but it is the natural acid of the grape—not that of faulty fermentation. This very acidity is a quality looked for by regular wine-drinkers, who find our less acid wines somewhat flat; it permits the addition of water without making the wine insipid.

I am aware that many will not share my views as to the feasibility of developing a big demand for such wine in Australia. I can almost hear the objection, "That is all right for a Latin people, trained from childhood to regard wine as a necessary of life. We are a different race —Anglo-Saxons will never learn to drink wine," &c.

I must disagree. Our climate is eminently suited for the change. Light, natural wine is the ideal beverage for this climate, just as it has proved itself to be for the Latin countries fringing on the Mediterranean. As Dr. Springthorpe told the Basic Wage Commission some three years ago, "The Australian is a Britisher living in a Mediterranean climate. . . . He is developing Latin characteristics, and will gradually go in a Latin direction of food and beverages. . . ."

If he has not made more progress, who is most to blame? Is it not the producers of the beverage? We have certainly done little to help him to become a wine-drinker—to effect this desirable change which would completely revolutionize our wine industry—because we have failed to place within his reach, at a reasonable price, the only type of wine which has rendered possible the universal adoption of this beverage by Latin Europe.

In order that we may develop a demand for wine of this type, two things are necessary—

(*a*) To provide the right kind of wine.
(*b*) To sell it at the right price and in the right way.

Can such Wines be Grown in Australia?

Undoubtedly they can. Even in the warmest parts of Victoria, wines can be grown of as low an alcohol strength as may be desired. The experimental wines, made each season for a good many years past, at the Rutherglen Viticultural Station are sufficient proof; and yet the wines generally produced in the Rutherglen district are as full-bodied as those grown anywhere else in the Commonwealth.

In order to produce wines of this type it is, in the first place, necessary to plant suitable varieties on the right class of soil. Heavy bearers are, of course, essential. Aramon and the Bouschet hybrids are well adapted for the purpose, but several others may be added to the list. The inclusion of a small proportion of one or more choice sorts, to increase bouquet or colour, might be made without unduly increasing cost of production or unduly retarding maturation. The vineyard should be planted on fairly rich, level land, rather than on the hillsides so suitable for fuller-bodied wines. The aid of irrigation can be usefully called in, as in Argentina. Vintaging would need to be at perfect maturity and before the grapes have become at all over-ripe.

Careful cellar manipulations are, of course, essential, not only during wine-making, but more particularly in subsequent handling. Our cellarmen, so long used to robuster wines, may at first find irksome the frequent filling up, necessary to adequately protect wines more susceptible to ullage. Their proper management, however, presents no serious difficulty; what can be achieved in French cellars can equally well be done here, and our wineries are quite as well equipped as those of France.

Preliminary Maceration.

I wish here to draw attention to the merits of the wine-making method known by this name, which was recently evolved in Algeria. It is peculiarly adapted to the making of wines destined for early consumption, owing to the greater delicacy and refinement they show, and their freedom from coarseness and excessive roughness, sometimes found even in our good dry wines when young. They retain a good deal of freshness and taste of fruit—*fruité*, as it is termed in French, which must not be confounded with fruitiness or sweetness.

Briefly, the new method consists in crushing and stemming in the usual way, and immediately sulphiting with four times the usual dose of SO_2; the commencement of fermentation is thus postponed for four days, during which time the juice macerates on the skins, extracting from them a sufficiency of tannin and colour. The juice is then pressed off and fermented apart from the skins, as for white wine. Maceration thus takes place *before* and not *during* fermentation, as is usual for red wine. Fermentation is slow at first, hence high temperatures are avoided; it is thorough and complete, and the colour is nearly as deep as with grapes treated in the usual way.

I have the honour to submit, for the information of the Congress, a sample of light red table wine, made by this method at the Rutherglen Viticultural Station during the 1922 vintage. The quantity made was 150 gallons; the grapes were mainly Aramon and the Bouschet hybrids (Alicante Bouschet and Calmette), with a little Corbeau and Mondeuse added, for colour and bouquet. The average gravity was 11° Baumé. Bisulphite of potash was added at the rate of 13 ounces per 100 gallons.

In submitting this result of our first experiment, I do not claim, of course, that finality has been reached. The wine has rather more colour

and body than *vin ordinaire* needs. Modifications might be made in several directions. I wish this sample to be only looked upon as an illustration of what can be done by the new method.

Different Methods Applicable.

The right kind of wine can, no doubt, be made in different ways. Whether preliminary maceration, the usual Southern French method, or something intermediate should prove the best, time will tell. The result aimed at is of more importance than the means by which it will be attained.

Similarly as regards type—we cannot forecast exactly what will ultimately find most favour—it will probably be rather less acid than the French type. In Spain the wine is usually less acid than in France, though there is not much difference in strength. We have already proved the London market, and know what it requires of us. It is strange that we should be less fixed as to what we want ourselves. Owing to the warmer Australian climate, it will, no doubt, be something lighter—an eleven, or perhaps even a ten, Baumé wine.

Whatever the exact type, and whatever the best way of making it, there is not the slightest doubt as to our ability to produce it, even in our warmest districts, and in such quantity per acre that it may be profiably sold at a cheap price, such as would permit it to be a household beverage, just as in Latin Europe.

Bulk Handling.

It is not enough to grow the wine so that it can be sold wholesale at a low price. The retail customer must also benefit. This implies bulk handling. Eliminate the bottling charges, and an enormous reduction in price is at once realized. Without bulk handling, wine could not be made available, even in the Latin countries, at the cheap rate which alone enables it to be an every-day beverage. In France no householder buys his *vin ordinaire* in bottle. He obtains from his wine merchant or grocer, in small cask or jar, a quantity sufficient to last some weeks or months; the bottling of this supply is either one of the ordinary domestic duties, or, if the cask be of fair size, a cooper is called in, who does the bottling at a moderate charge.

Customers are so numerous that the retailer sells a sufficient quantity to avoid having receptacles "on ullage" for more than a few hours; deterioration from this cause does not, therefore, occur. It is this need to avoid exposure of light wines to air, that makes our retailers so reluctant to handle them; they prefer to stock sweet wines, which support contact with air with impunity. Customers for light wine are so few that the vendor has to keep a hogshead on tap for a week or more, with the result that about half the contents of the cask is delivered in such bad order as to deter customers from seeking further supplies.

Retailing under CO_2 Pressure.

These difficulties can be quite easily overcome; all that is necessary is handle the wine, whilst on draught, under slight carbonic acid pressure in much the same way that beer is now served in many bars, but with this difference, that a much lower pressure is needed. Reducing valves are now obtainable, capable of delivering gas at a pressure as low as 2 or 3 lbs. per square inch—just enough for it to immediately fill the space vacated by the withdrawal of some wine, to the complete

exclusion of air. A hogshead or puncheon, thus equipped with CO_2 cylinder and reducing valve, could remain on tap, and ullaged, for several weeks, if necessary, and the last lot of wine withdrawn would be in as good order as the first.

A simple device of this kind would make the sale of light wine as popular with retailers as is now that of the sweet wines, which form so large a proportion of the present retail trade. The customer, receiving his wine in perfect condition, instead of flat, cloudy, and even more or less pricked, as he sometimes does now, a demand for light dry wine would be created such as is not now generally realized.

Retailing of Wine—A Few Suggestions.

I approach this part of the subject with diffidence—my duties have more to do with technical than commercial aspects—and yet as one who has the best interests of the industry sincerely at heart, I feel compelled to refer to one of the main reasons why there is not a far greater consumption of the high-class wines we now bottle. These wines certainly belong to a more expensive class than *vin ordinaire*, which they cannot, therefore, replace as a family beverage. Their consumption would, nevertheless, be very much larger than it is to-day were it not for the differential treatment met with by wine and beer in the majority of Australian restaurants and hotels.

How is it that the retailer is content with a profit of 15 or 20 per cent. when he sells beer, but considers himself entitled to over 100 per cent. when he sells wine? The man who drinks wine is fair game. "He's a toff and can afford to pay" seems to be the attitude of the majority of eating-houses. Light wine is an ideal beverage to be consumed with meals—not between them. The restaurant should be our main outlet—not the wine shop. And yet, in most restaurants, the price charged prohibits the every-day consumption of our wine to all but the wealthy or the prodigal. It is strange that the wine-grower has so long tolerated being thus penalized. Until he insists on similar treatment to that which the brewer gets, there can be no marked increase in wine consumption.

Two innovations could, in my opinion, be introduced for the great good of our wine industry. The first is a new form of licence—a restaurant licence, such as would permit the sale, *exclusively* with meals, of wines of light type. This licence would not be in substitution for, but in addition to, existing licences.

The second is a new sort of bottle. The ordinary or "reputed" pint bottle is an unsatisfactory size. As the exquisite said of the egg, "It's too big for one, and too little for two." The "baby" bottle, on the other hand, is too small for one. A bottle of imperial half-pint size should just meet the case, and, if sold at a reasonable price, do much to popularize the drinking of wine with meals.

Our wine industry has reached important proportions, of which we are justly proud—and yet what is it compared with those of the leading wine nations? Of France, for instance, where 1,760,000,000 gallons were vintaged last year, and where, among rural industries, the vine ranks second only to wheat. The Australian drinks three bottles of wine a year; the Frenchman a quarter-cask. A large increase in our wine consumption would benefit our country, our people, and, of course, our vine industry. It seems to the writer that the best way to foster such an increase would be to make available, at a cheap price, wine, perhaps not indentical, but of somewhat similar type, to that which is so enormously popular in France.

TOBACCO-GROWING IN UNITED STATES.

The following Progress Report has been received by the Department of Agriculture from Mr. Temple Smith, who left Victoria three months ago commissioned by the Government to inquire into and report upon the most successful and modern methods of tobacco culture in the United States, and to arrange for the migration here of tobacco-growing settlers:—

I have to report that I am at present in Chatham, Virginia, one of the most celebrated districts for the production of high-class bright tobacco leaf, known as the Piedmont Section of the Old Belt. The Department of Agriculture of the United States has an Experimental Tobacco Farm of 50 acres here, and I have been in frequent communication with the manager, Mr. T. Copley, who has given me much assistance and information.

This State in 1921 had under tobacco 167,000 acres which produced tobacco to the amount of 91,550,000 lbs. of leaf, ranging from the highest class cigarette to the bright smoking tobacco. The soils used for tobacco culture are grey to light-red in colour, built up from sandstone formation chiefly, with some granite and shale. They are poor in quality, and require heavy fertilizer dressings to enable them to produce any crop, and up-to-date tobacco-farmers grow only one crop of tobacco in three years, following a rotation system of first year tobacco, second year wheat or rye, third year red top or herd's grass, or peas, and tobacco again. Even new land is heavily fertilized, and Victorian growers on poorer soils have much to learn in this respect.

The altitude of Chatham is 500 feet, and the land is undulating to hilly and liable to erosion with heavy rains. Soils in Victoria which may be compared with these in Virginia are to be found in considerable areas on the King River Valley around Whitfield, and on the Ovens, Mitta, Kiewa, and Upper Murray Valleys, though the lands now devoted to tobacco in these parts of Victoria are richer naturally than those used in Virginia, and, consequently, produce heavier and coarser leaf. There is much land along the foothills of the valleys mentioned, however, that will in the future produce tobacco more of the Virginian type.

The rainfall here is considerably heavier than is the case in the tobacco areas in Victoria. An annual fall of 50 to 60 inches is usual here, and an average of 3 to 5 inches falls during the growing season, monthly, though good crops have been grown on much less than this, and the wetter seasons make trouble in causing erosion, disease, and weed-growth. With good cultivation Victorians should find in average seasons the rainfall sufficient where tobacco is now grown.

Land in this particular district costs £30 per acre, cleared but without buildings. Similar land can be purchased in Victoria for from £4 to £8 per acre. Virginian growers apply from 1,000 to 1,400 lbs. of fertilizer per acre for tobacco, and would not consider an attempt to produce a crop without such help. This is where Victorian growers on the lighter soils have much to learn, as not only is the yield increased, but the quality greatly improved and the growing season shortened. The fertilizers used consist of dried blood or nitrate of soda, superphosphate, and sulphate of potash, for preference at the rate of 375 lbs.

of dried blood, 700 lbs. of superphosphate, and 100 lbs. of sulphate of potash. On the richer land down to half these quantities are applied.

The land is cultivated four to six months before the transplanting season, and kept as clean as possible. Just before transplanting a light furrow is drawn every 3 feet and the mixed fertilizer distributed along the bottom. Another furrow from each side is then turned over on to this, and on the hill so made the plants are put in, and the soil between the rows worked down and finally worked back towards the plants, until they are hilled up much as a potato crop is hilled in Australia. It is doubtful, however, whether this practice in cultivation would suit our conditions, which are drier, and probably one reason for the system adopted in Virginia is to provide easy drainage after heavy rains.

Seed beds are made in new land each year, and a patch in the forest is cleared and burned, preferably with a south-eastern aspect and shelter from the cold northern winds. A dressing of 200 lbs. of complete fertilizer is used on each 150 square yards of bed, and the whole is covered with cheese cloth until about ten days before the plants are drawn for transplanting.

American growers allow the plants to become more advanced in growth than do Australians, and claim that a plant 6 to 8 inches in length is stronger and grows better than smaller ones. They are put deep in the ground when transplanted, the rule being to put them down to the heart, or bud, and in ordinary seasons they are neither watered or covered, though this season being exceptionally dry, watering is being done in some cases. The crop in this district is always planted if possible between the middle of May and middle of June, and takes from 90 to 100 days to mature. The crop is topped as soon as the requisite number of leaves can be obtained, and ten to twelve leaves are considered sufficient on these soils.

When harvesting some growers prime the leaves as they ripen, others cut the whole plant, and some prime the first leaves to ripen, and cut the plant with the balance.

All tobacco here is flue-cured in log barns, which are primitive but very satisfactory, and of this process I will report fully later.

The average yield of tobacco per acre in this section is 550 lbs., and the average price 1s. 3d. On these figures the American grower does not reap as great a profit per acre as the Australian, especially when the cost of fertilizing is taken into account. Growers with whom I have talked estimate the whole cost of production at from 7d. to 10d. per lb.

There are many pests in America that Australia is free from, but in this district the Australian arch-enemy, Blue Mould, is not known. I have already heard of a variety which is said to be disease-resistant to a greater degree than others, and which is peculiarly adapted to dry and hard conditions, yet produces a fine type of tobacco, named Lizard Tail, some seed of which I am securing.

One advantage the United States grower has is in the choice of machinery, and the cost of same. A double-row cultivator of better make than any I have seen, costs only £12, a waggon about half the Australian cost, and other machinery in proportion.

Up to the present I have had only a short experience with tobacco-growers in this country, and intend to go into other phases of the industry in future reports. I feel sure that there is much to be learned of value to Australians, and I have received the greatest kindness and hospitality from each and every one with whom I have come in contact.

WEEDS AND THEIR ERADICATION.

(Continued from page 441.)

By H. W. Davey, F.E.S., Orchard Supervison Branch, Department of Agriculture.

Common Furze, *Ulex Europœus,* L. Family; *Leguminosæ.*

This exceedingly common plant is well known under the several names of furze, gorse, or whin. It is probably an importation from England, where it is very plentiful on the poorer classes of soil, and when covered with its masses of golden blossoms often becomes quite a feature of the landscape (Figure 68).

Furze is a much-branched, spreading shrub. It is evergreen and perennial with hard spiny leaves excepting when the plant is in the seedling stage. When well grown its coarse woody spiny branches make an almost impenetrable mass of vegetation, except to rabbits and other vermin, which find seclusion under its thorny branches and sanctuary from most of their enemies.

The seed vessels burst with a crackling noise during hot weather, the pods drying in such a way as to produce a strong tension which causes them to split apart violently, thus causing the seeds to scatter themselves at some considerable distance from the parent bush.

Furze when neglected soon becomes a most troublesome weed owing to its deeply-growing root system, perennial nature and general robustness, while its seed-throwing habit also assists in its rapid spread over considerable areas of land.

Probably the best method of eradication is first to burn off the bushes and afterwards dig out the stumps and roots. Cultivation will easily control furze, but as it is essentially a pest of waste lands or of grazing areas, most of the ground on which it is growing is unfit for the plough; therefore its eradication by this means need not be considered here.

After the furze has been burnt off and its roots grubbed out, numerous seedlings will arise from dormant seeds that have been previously scattered. These seedlings when numerous can easily be dealt with by sprayinig them lightly with an arsenical weed-killer, or the more expensive method of hoeing them out can be adopted.

If the fertility of the soil be improved by the addition of manure, and a better class of herbage thus encouraged, grazing stock will eat out the immature and tender seedlings.

Furze and the blackberry, fortunately, are both proclaimed for the whole of Victoria under the provisions of the Vermin and Noxious Weeds Act. Fortunately, because both have spread very rapidly of late years over large areas of privately-owned and Crown lands, and each of the species affords such ideal cover for imported

Fig. 68.—Common Furze, *Ulex Europæus*, L.

vermin, which take naturally to the shelter, that these two plants and vermin always seem to be associated. Probably both the rabbit and fox in Europe have availed themselves of the hospitable shelter given them by these plants over a great period of time, so that now they instinctively resort to this dense cover.

In fact, in the case of the blackberry, there might almost be said to be a symbiotic relationship between it and the fox, as while the blackberry provides the fox with safe and warm shelter, he, by feeding on the ripe berries, distributes the seeds over wide areas, and thus becomes a leading factor in the dispersal of this species,

In view of the suggested introduction of certain pest insects from America to Australia for the purpose of destroying prickly pear, it is worth mentioning that furze affords another excellent example of an insect changing from its natural food plant to another of a widely different species, and incidentally points out the great danger of introduced pest insects doing likewise and changing their host plant.

A cerambycid beetle belonging to that fine genus *Uracanthus* feeds naturally on the indigenous native hop, *Daviesia latifolia*. (See the *Victorian Naturalist*, volume XXIV., page 155.) This beetle *U. bivitta*, has developed a strong liking for the wood of the introduced furze, the stems of which it frequently tunnels in the manner characteristic of the species. In New South Wales another species of the same genus, *U. cryptophagus*, is reported to have turned from its native shrub to the cultivated orange tree, which is now often seriously damaged by its larva.

In this instance we have a native species of insect attacking an introduced plant, affording yet another illustration of an insect enlarging the range of plants that are suitable for the food of its larvæ.

Beetles of the former species reared from the stems of furze are in no way inferior in size or colouration to those reared from their native plant food, which proves conclusively that the change of food agrees with them. Of course the clearing of land for settlement will have the tendency to force many insects to acquire new tastes in food, but in many cases the diet is changed and a new taste acquired long before any shortage of their original food becomes acute.

The important fact that stands out, however, is that no one can say what plant will be immune from attack either by native or introduced insects, and it is here where the great danger lies in introducing pest insects into Australia, the danger of which becomes much greater when it is remembered that care is always taken to introduce such insects without their natural controls.

In view of the great importance now being attached to the cultivation of cotton in Australia, and the reported introduction of pest insects to assist in the eradication of prickly pear, this phase of the question must, or at any rate should, be considered very seriously at the present time.

The cotton plant appears to be one that is likely to be sought after by insects of different orders, and in addition to the likelihood of its being attacked by our native insects that may acquire a liking for it, there is the further danger that later on introduced insects, whose only qualification is their known destructiveness to vegetable life, may develop a taste for it.

(To be continued.)

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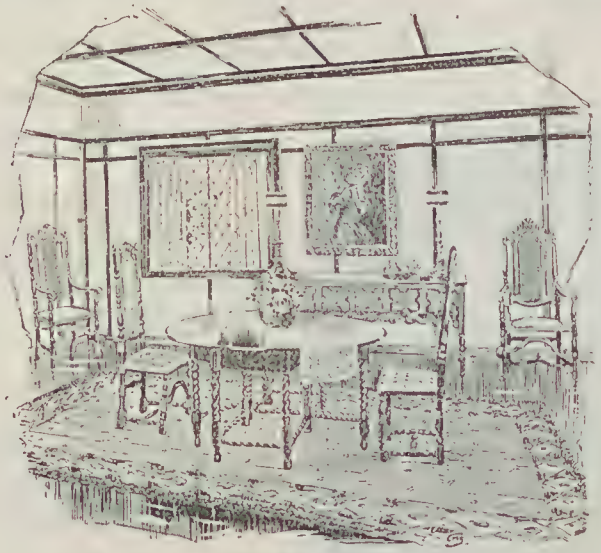

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WILLIAM ADAMS & CO. LTD.

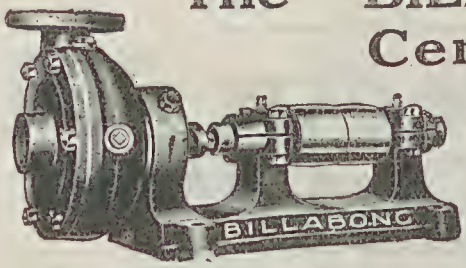
521 COLLINS STREET, MELBOURNE

and Sydney, Brisbane, Newcastle, Adelaide, Perth, and Launceston

PUMPS

For Irrigation and other purposes

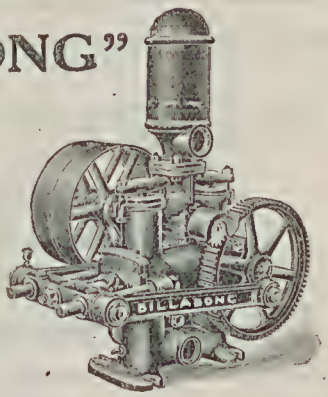
The "BILLABONG" Centrifugal



is a sturdy example of first-class Australian workmanship. It is specially suitable for irrigation purposes as it delivers large quantities of water and is constructed to stand hard and continuous service. Every feature of its design and construction is contributory to the one object—MAXIMUM EFFECTIVENESS!

The "Billabong" Centrifugal is made in sizes ranging from 1 in. to 8 in. Suction and Discharge are readily adjustable to any angle, and the capacity can be varied considerably without loss of efficiency. Write for illustrated descriptive leaflet "S.1."

The "BILLABONG" Double Acting Piston Pump



The chief feature of this pump is ample capacity in a most compact form. It is specially adapted to meet the demand for a medium priced power pump to be operated by kerosene or petrol engines, or other belt power. It will operate satisfactorily against a total head of 175 feet. The gearing is cut from the solid. Suction may be taken from either side and delivery in four different directions. ——— Write for leaflet "S.2."

If you have any kind of pumping proposition, ask us for particulars of a suitable plant. Our expert advice is at your disposal—gratis

JOHN DANKS & SON PTY. LTD.

DANKS

391-403 BOURKE ST. MELB.

and at 324-330 Pitt St., Sydney

PARSONS BROS. & CO.

Propy. Ltd.

OATMEAL, SPLIT PEAS, and
PEARL BARLEY MILLERS
and "CORNINA" MANUFACTURERS

—ARE—

BUYERS of OATS, PEAS, BARLEY, and MAIZE.

SEND SAMPLES OF YOUR GRAIN TO US.

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G.P.O., MELBOURNE.

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CREDIT FONCIER

Loans on Farms

Up to two-thirds of valuation in sums from £50 to £2,000, repayable by instalments spread over a period of 27½ years. Interest 6 per cent. per annum.

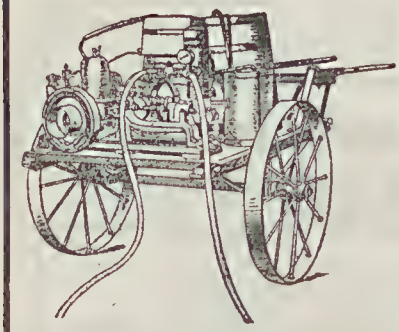
Special Terms for Discharged Soldiers and Dependants, also those who were in **Red Cross and Transport Services,** up to three-fourths of valuation, repayable by instalments spread over a period of 30¼ years. Interest 5¾ per cent.

NO CHARGE FOR MORTGAGE DEED

Application forms obtainable at any Branch of the State Savings Bank.

State Savings Bank,
Head Office—Elizabeth Street, Melbourne

GEO. E. EMERY,
Inspector-General



Spraying Machinery

for all purposes

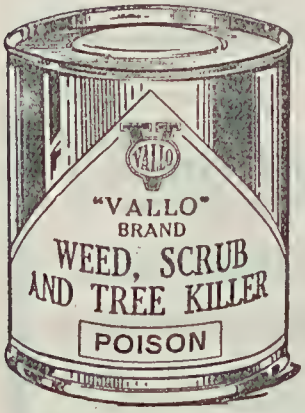
ORCHARD, VINEYARD, AND FARM

RUSSELL & CO.

Whitehorse Road, Box Hill,
MELBOURNE

Makers of the famous BAVE-U Sprayer

TREES and SCRUB
ST. JOHN'S WORT
THISTLES BRIARS
BLACKBERRIES
BOXTHORN
COUCH FERNS
FURZE SORREL



NOXIOUS WEEDS

Every square foot of ground is valuable now-a-days—far too valuable to be usurped by undesirable weeds and scrub. Why should they sap the vitality out of ground which should contribute to your storehouse or granary?

"VALLO" Brand Weed Scrub and Tree Killer

is the speedy, sure, and economical means of cutting short their existence. "VALLO" is not an experiment. It is an absolute exterminator of any and every kind of noxious growth. Whether your trouble be giant trees or common sorrel, put "VALLO" on the job and you'll be impressed by what it can do.

PRICES—56 lbs., 70/-; 15 lbs., 21/3;
7 lbs., 10/6; 1 lb., 2/-; ½ lb., 1/3

Manufactured by

A. VICTOR LEGGO & CO.

Melbourne — Sydney — Brisbane

FOR TOP PRICES——CONSIGN YOUR

WOOL, GRAIN, PRODUCE, FAT STOCK

——TO——

AUSTRALIAN, MERCANTILE,

Land and Finance Company Limited

MELBOURNE

Sales of Sheep and Cattle held Weekly at Newmarket

THE

Farmers & Settlers' Co-Operative Insurance Co.

OF AUSTRALIA LIMITED

The only Co-Operative Fire Insurance Company in Victoria Owned and Controlled directly by the Farmers and Graziers

OVER 7,000 FARMERS AND GRAZIERS ARE SHAREHOLDERS IN THE FARMERS AND SETTLERS

You can only share directly in the Profits of an Insurance Company when you are a Shareholder

The Farmers and Settlers is Supported by different Co-Operative Trading Companies in Australia, representing 75,000 Shareholders

Over £17,000 has been distributed in Dividends to Farmers and Graziers in the past few Years

FARMERS AND GRAZIERS, SUPPORT THIS COMPANY WITH ALL YOUR INSURANCES, WHEN DIVIDENDS AND BONUSES TO YOURSELVES WILL BE INCREASED CONSIDERABLY

Full Particulars from any Agency of the Victorian Producers' Company, or H. L. CARROLL, Manager, 360 COLLINS ST., MELBOURNE.

Dairying Made Profitable!

by using

The World Renowned

"BALTIC" SEPARATOR

Efficient, Durable, Easy Running

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"SIMPLEX" Milking Machines

More economical, efficient, and sanitary than hand milking

Write for opinion of up-to-date dairymen

BALTIC OIL ENGINES

Suitable for all classes of farm work.

ILLUSTRATED DAIRY MACHINERY CATALOGUE J.A. FREE ON APPLICATION

BALTIC-SIMPLEX MACHINERY CO. Pty. Ltd.

491-493 Flinders Lane, MELBOURNE

Department of Agriculture, Victoria.

PURE FRIESIAN HERD

Bull Calves for Sale

(1) Bull Calf dropped 24th January, 1923

Sire: Victoria Songboy (359) by Dominion Domino Dutch Boy (1206 N.Z.F.H.B.)
Dam: Dominion Belle Corona (369) by Oak de Kol 2nd Homestead Fobes (imp.) (341 N.Z.F.H.B.)

Dam's Record for 273 days under Government Herd Test—
11,646 lbs. Milk, 3·61 Test, 420 lbs. Butter Fat.

For Full Lactation Period—
11,715 lbs. Milk, 3·61 Test, 424 lbs. Butter Fat.

(2) Bull Calf dropped 26th February, 1923

Sire: Victoria Songboy (359) by Dominion Domino Dutch Boy (1206 N.Z.F.H.B.)
Dam: Dominion Proud Lassie (368) by Woodcrest Jo (imp.) (334 N.Z.F.H.B.)

Dam's Record for 273 days under Government Herd Test—
11,336 lbs. Milk, 3·42 Test, 387 lbs. Butter Fat.

For Full Lactation Period—
12,216 lbs. Milk, 3·51 Test, 428 lbs. Butter Fat.

Victoria Songboy's dam Dominion Madrigal's Record for 273 days under Government Herd Test is 11,373 lbs. Milk, 3·93 Test, 448 lbs. Butter Fat; and for Full Lactation Period 13,485 lbs. Milk, 4·17 Test, 563 lbs. Butter Fat.

(3) Bull Calf dropped 3rd May, 1923

Sire: Victoria Jo Patch (345) by Longbeach Big Patch (515 N.Z.F.H.B.)
Dam: Dominion Coringa (380) by Woodcrest Jo (imp.) (334 N.Z.F.H.B.)

Dam's Record for 273 days under Government Herd Test—
13,923 lbs. Milk, 3·58 Test, 499 lbs. Butter Fat.

For Full Lactation Period—
16,373 lbs. Milk, 3·62 Test, 593 lbs. Butter Fat.

(4) Bull Calf dropped 18th May, 1923

Sire: Victoria Jo Patch (345) by Longbeach Big Patch (515 N.Z.F.H.B.)
Dam: Victoria Dutchmaid (991) by Dominion Domino Dutch Boy (1206 N.Z.F.H.B.)

Dam's Record for 273 days under Government Herd Test—
6,054 lbs. Milk, 4·01 Test, 243 lbs. Butter Fat.

For Full Lactation Period—
7,156 lbs. Milk, 4·06 Test, 290 lbs. Butter Fat.

Victoria Jo Patch's dam is also Dominion Madrigal (record as above).

INSPECTION of these Bull Calves at the Horticultural Gardens, Burnley, is invited.

APPLICATION FOR PURCHASE to Dr. S. S. Cameron, Director of Agriculture, Melbourne.

DEPARTMENT OF AGRICULTURE, VICTORIA

Red Poll Dairy Herd

The Department will shortly have completed the orders for calves that were booked ahead of calving when the advertisement was withdrawn; consequently the booking of orders for bull calves from the forthcoming calvings has now been resumed.

BULL CALVES are sold for delivery at a month old at prices based approximately on the actual milk and butter fat record of the dam at the rate of 1s. per lb. of butter ***fat*** yielded.

(For Record of Yields of dams see Red Poll Herd Book.)

The Bulls in Use include—

LONGFORD MAJOR (Imported)

Dam's Record 14713 lbs. milk ... 6 years average 11338 lbs. milk
G. Dam's ,, 10548 ,, ... 4 ,, ,, 9135 ,,

BELLIGERENT (Imported)

Dam's Record (1st milking) 7144 lbs. milk.

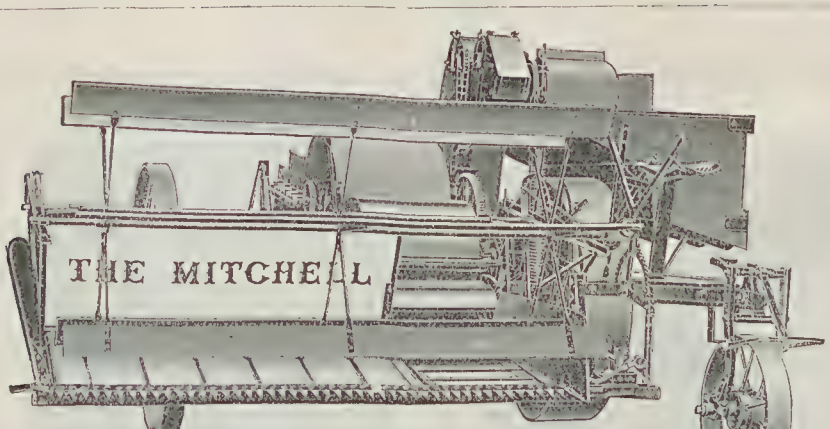
Dam's Dam's	,,	14533 lbs. milk	...	4 years average	12871	lbs. milk
Sire's Dam's	,,	10370 ,,	...	7 ,, ,,	9354	,,
Sire's D. Dam's	,,	9510 ,,	...	12 ,, ,,	8033	,,
G. Sire's D. Dam's	,,	10215 ,,	...	7 ,, ,,	9386	,,
G.G. Sire's D. Dam's	,,	12565 ,,	...	10 ,, ,,	8853	,,
G.G.G. Sire's D. Dam's	,,	10088 ,,	...	2 ,, ,,	9754	,,

Inspection of the Herd is Invited.

Visitors will be met at the Station on notifying the Manager, State Research Farm, Werribee.

Application for purchase to

Dr. S. S. CAMERON, DIRECTOR OF AGRICULTURE, MELBOURNE.



Mitchell Headers

Stand the Strain

If the parts of a Header are spread out too much, energy is wasted and strength is sacrificed, so that in a few years trouble starts and the machine is undependable for the heavy strain of harvesting.

MITCHELL headers are very compact and are built low; moreover, every machine is "built," not "thrown together." Therefore, they stand up to hard work better than others. Compare it with others as to design and workmanship and you will have a MITCHELL.

The simplicity of design is remarkable. After the heads leave the platform, they go in a straight line (without turning) "head first" through the thrasher—the only efficient way. This means better thrashing and an early start in the morning.

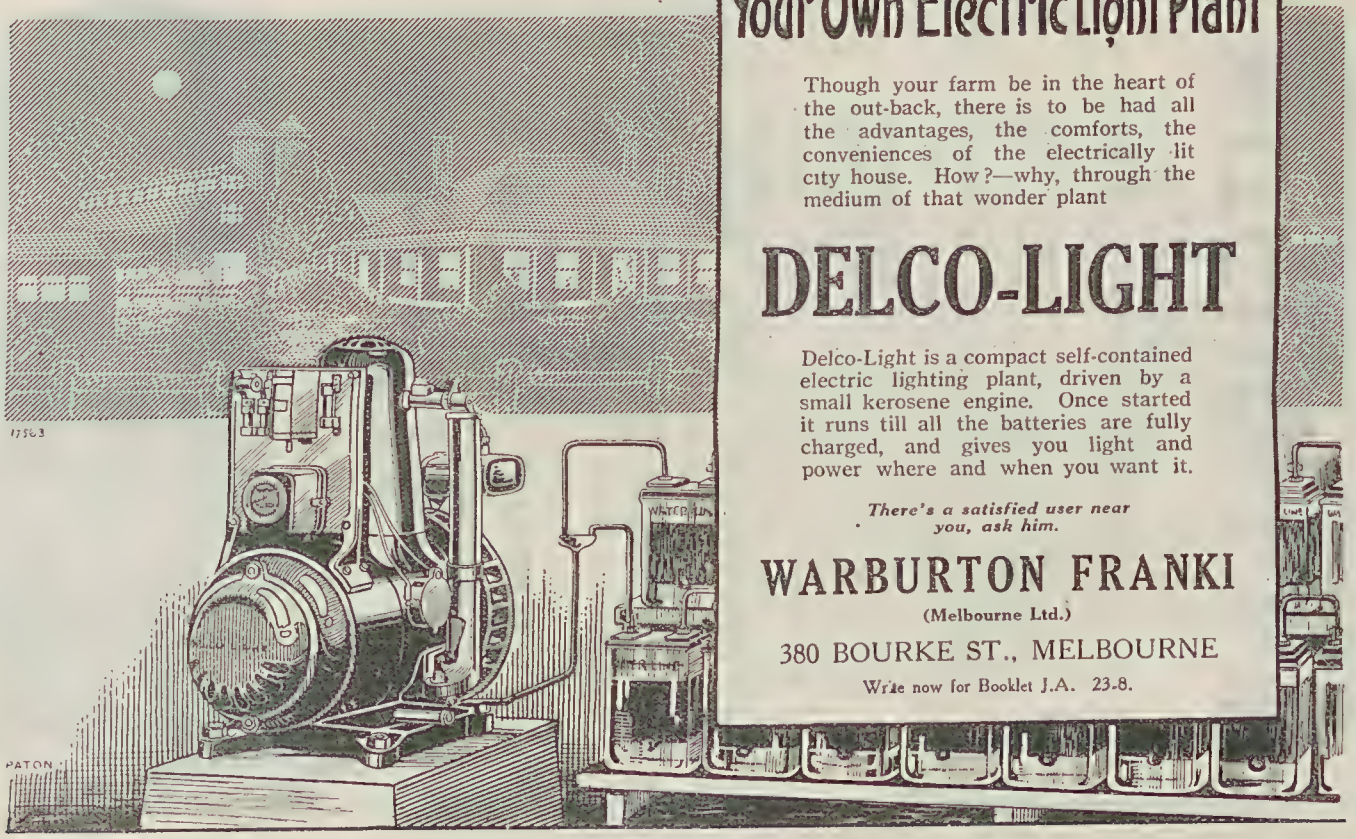
The MITCHELL is especially good in thistles, musk, &c. Many crops have been taken off with it that other machines failed to handle.

MITCHELL & CO. PTY. LTD.

WEST FOOTSCRAY.

596 BOURKE STREET, MELBOURNE. BURWOOD (SYDNEY).

AGENTS EVERYWHERE.



Your Own Electric Light Plant

Though your farm be in the heart of the out-back, there is to be had all the advantages, the comforts, the conveniences of the electrically lit city house. How?—why, through the medium of that wonder plant

DELCO-LIGHT

Delco-Light is a compact self-contained electric lighting plant, driven by a small kerosene engine. Once started it runs till all the batteries are fully charged, and gives you light and power where and when you want it.

There's a satisfied user near you, ask him.

WARBURTON FRANKI

(Melbourne Ltd.)

380 BOURKE ST., MELBOURNE

Write now for Booklet J.A. 23-8.

DEPARTMENT OF AGRICULTURE

GOVERNMENT COOL STORES

VICTORIA DOCK

The Stores have a capacity of **743,980 cubic feet insulated,** and are capable of holding **372,000 boxes of butter,** or **248,000 cases of fruit,** or **335,000 carcasses of lamb and mutton.**

Electric motor power totals 900 H.P.

Produce can be placed on conveyors at any point and mechanically carried to any chamber in the building, or conveyed from the chambers direct into the ship's hold.

The Railway Department Goods Sheds are adjacent to and connected with the Cool Stores by direct lines; delay and exposure of produce through shunting in the Spencer-street yards, or cartage, are thus avoided. The Stores are situated in close proximity to the Victoria Dock, where vessels drawing up to 30 feet of water can be berthed; excellent facilities for the efficient and economical treatment and shipment of frozen and perishable products are provided.

Expert Officers are connected with every Branch, so that any one requiring information regarding the production, preparation, and shipment of produce can rely upon being promptly supplied with up-to-date information upon all matters.

LUCERNE
THE KING OF FODDER · CROPS

"The crop that gives a continual harvest without an annual ploughing or seeding."

YEAR by year this King of Fodder Crops is proving its adaptability to varying situations, soils, and climates. At one time it was thought that it would be a sheer waste of seed to sow anywhere but on choice alluvial flats; but now we find Lucerne extensively grown on **ordinary good agricultural land** and even on **hilly upland country.** Of course it is not suggested that such heavy growths or so many cuts in the season occur on the hilly land as are produced on typical Lucerne flats, but even where Lucerne does only moderately well **there is no other crop to compare with it.**

Write for YATES' BOOKLET ON LUCERNE GROWING, Post Free.
It will give you much information.

We are Head-quarters for
N.S.W. Saved Lucerne Seed

We are convinced that for Australian conditions no strain of imported seed can compare with the best of our own local saved Lucerne. This has been proved in our own Trial Grounds, in Government Tests, and by the experience of all large users, and is even confirmed in other countries in which climatic conditions are similar, where our Lucerne seed has proved to come quicker in the Spring and give a later cut in the Autumn than any other strain. We cannot recommend and therefore do not stock imported Lucerne seed of any description, nor do we stock local seed which has been grown on irrigation areas.

YATES' BROADLEAF A.Y. GIANT-UPRIGHT LUCERNE

Yates' Broadleaf A.Y. Giant Upright Lucerne is sold only in sealed and branded bags, and is re-machined and tested seed of extra prime quality of a superior type of N.S.W. grown Lucerne, saved on selected Farms in those districts in which owing to special natural conditions there has been evolved a long standing drought-resisting strain which has proved itself for Australian conditions. Each bag carries particulars of germination and purity.

Yates' Broadleaf A.Y. Giant Upright Lucerne can be obtained through our country agents in 25 lb. and 50 lb. net sealed bags printed with our own brand, or will be supplied direct to Farmers in any quantities required.

NOTE SPECIALLY—We deliver Seed at the following Sydney quotations **FREE ON RAILS MELBOURNE** in any quantity

Per lb. (in small quantities)	- -	2/4
50 lb. or over - - -	per lb.	2/3
5 cwt. or over - - -	,,	2/2

Over 10 cwt.—Special quotations according to quantity.

Samples and all other information on application.
Prices subject to market fluctuations and to alteration.

ARTHUR YATES & CO. LTD.

Suppliers of Re-Cleaned and Tested Farm Seeds

184-188 SUSSEX ST., SYDNEY

G.P.O. BOX 2707 ———— **Telegrams—"SEEDSMAN," SYDNEY**

By Authority: Albert J. Mullett, Government Printer, Melbourne.

Our Engineering Service counts with the Farmer

It means continuous operation at lowest cost with the

CASE

Kerosene Farm & General Purpose Tractor

WE have found, from actual experience, that to simply sell a farmer a Tractor is not sufficient—he must have a guarantee of permanent efficient service.

The guarantee of this to a Case Tractor buyer, is our Engineering Service—trained men backed by well-equipped Engineering Workshops. What this service means to the Farmer, may be judged by the following fact.

CASE Service Engineers instruct the farmer and are always available to put matters right in the shortest possible time, if trouble is experienced.

It is being proved all over Australia that the CASE Kerosene Tractor is the discriminating Farmer's choice; there are two distinct reasons for this—*first*, because of its efficiency, and *second*, the helpful Engineering Service that goes with the CASE.

The CASE Tractor is so constructed that all necessary repairs can be done in the field, and spare parts are stocked by all our branches throughout Australia.

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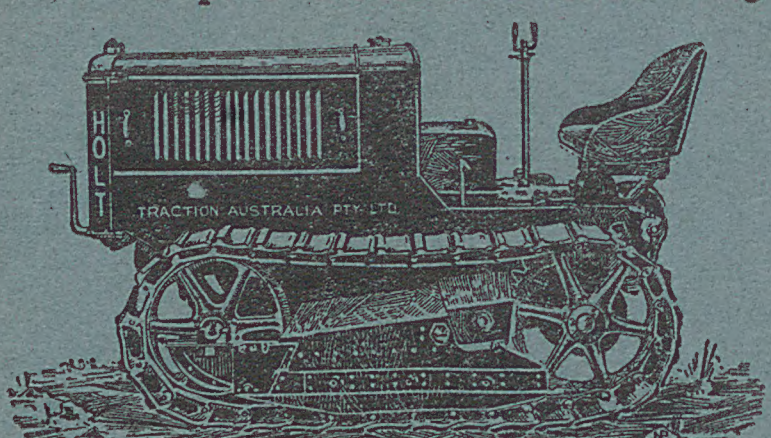
25 H.P.—3 Speed and Reverse—Electric Lights



"HOLT" CATERPILLAR "HOLT"

Model T 35 Tractor

A Tractor that weighs approximately 4,000 Pounds, that has 15 Horse Power at the drawbar, that is only 4 feet wide.—These, in brief, are the specifications of the T35 "Caterpillar" Tractor. Big capacity for work, exceptionally low fuel and oil cost, minimum upkeep expense. That sums up its performance. Add to these the features of adaptability to an extremely wide range of work and to ALL kinds and conditions of ground and weather, ease of operation, simplicity of construction, perfect accessibility, and you have the IDEAL Tractor.

IDEAL for all classes of Farm work, such as Plowing, Seeding, Harvesting, Tank Cleaning, Sawing, Pumping, Threshing, &c.

IDEAL for all Agricultural work under any conditions, and IDEAL for Road making or any Tractive Power.

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